RADIO EQUIPMENT OF THE THIRD REICH

1933-1945

CHARLES J. BARGER

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by Charles J. Barger
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ACKNOWLEDGMENTS

This concludes my work on communications equipment of the German army. The purpose of this series is to provide the reader with as much detail as possible on the actual use of the equipment. The book does not get into historical events. This comes to mind with the ENIGMA coding machine. There are numerous books available on how Allied intelligence sources cracked the code of the German high command; therefore, it is not discussed in this work. The reader will, however, be taken through the actual steps necessary to use the equipment, which is fascinating in itself.

Several individuals deserve special thanks for the selfless assistance they provided in the preparation of this book. Stephen Schriner of Marcopa, Arizona, provided all the information and photographs of the ENIGMA coding machine. From the Netherlands, Anton Breuker provided all the photographs of the 15-watt transceiver, which were extremely hard to locate. Klaus Brase of West Germany played a significant role, spending at least two weekends driving great distances to acquire photographs of the 30-watt and 80-watt transmitters and the Torn Fu.g transceiver.

Because detailed information was unavailable in the English language, German manuals had to be located and translated into English. This was a tremendous task, and a special word of thanks is due to Eric Uhle, who was a key player in this regard. Eric took on and rapidly produced direct translations on the field teletype printer, the ENIGMA coding machine, and coding instructions for the ENIGMA machine.

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Linda Barger
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Unless otherwise noted, all photographs and illustrations will be credited to the author. Format varies in this book in that due to the technical complexity of the subject, Chapters 8, 9, and 10 are direct translations of the German manuals.

GLOSSARY OF GERMAN TERMS

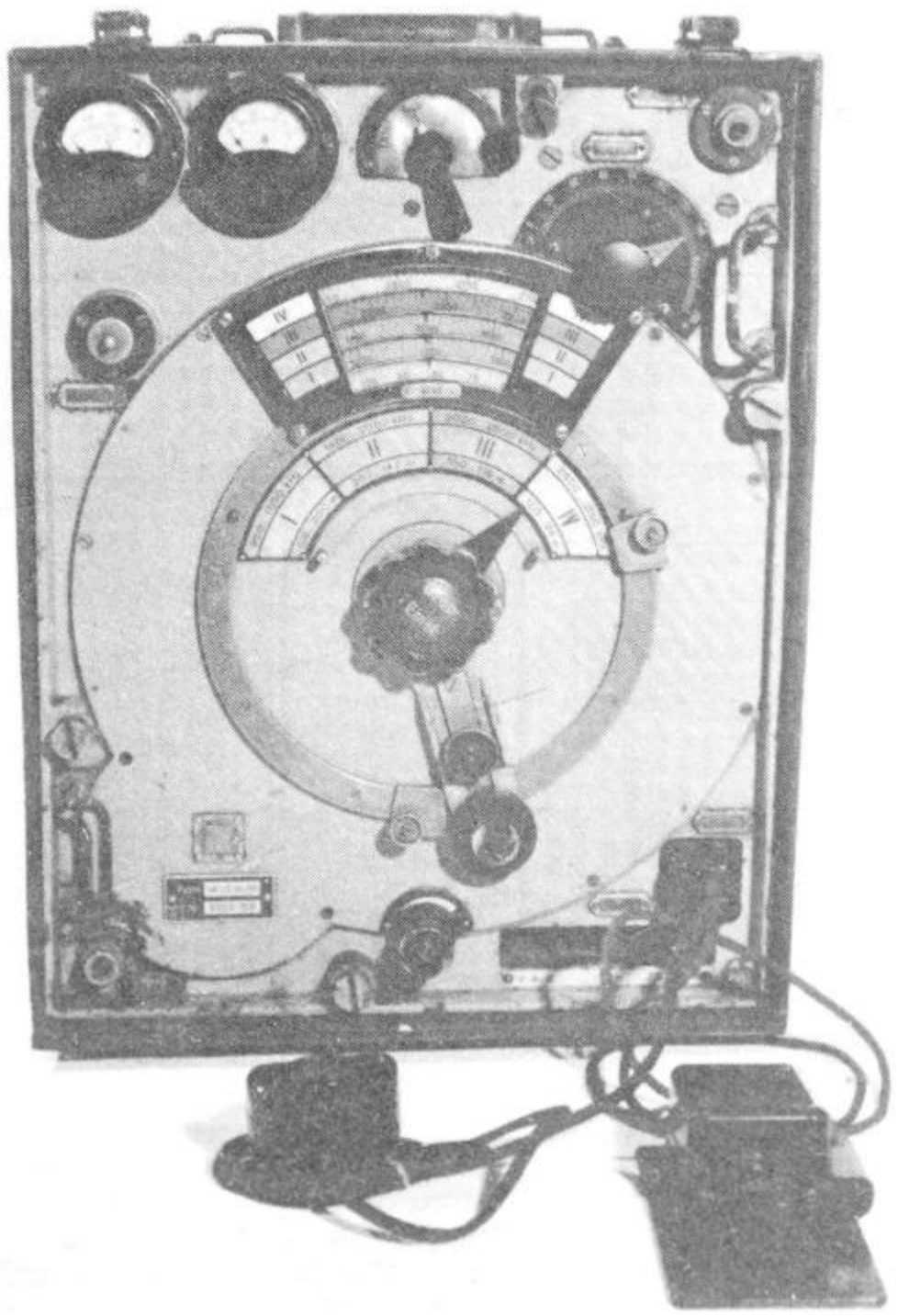
A	Ant.	antenna
	Ant. Abst. Fein	antenna fine tuning
	Ant. Abst. Gross	antenna coarse tuning
	Ant.-Strom	antenna current
	Antenne Empf. (Ant. Empf.)	antenna receiver
	Antenne Sender	transmitter antenna
	Antenne-Kopplung (Ant.-Kopplg.)	antenna coupling
	Antennenabstimmung	antenna tuning
	Aus	off
B	Bandbrite	selectivity dial
	Bereichschalter	band switch
	Bereit	ready
D	Dunkel	dark
E	E.	receiver, receive
	E.-Ant. Anpass.-S.	receiver and transmitter antenna trimmers
	Ein	on
	Empf. Abst.	receiver tuning button
	Empf.-Ant.	receiver-antenna
	Empfang (Empf.)	receive
	Empfanger Nachstimmung	receiver fine tuning
	Ersatzsicherungen	spare fuses
F	Fein-Abstimmgriff	micrometer adjustment lever
	Fernbesprechung. (Ferbespr.)	remote, remote control jack
	Fernhorer	headphones
	Fest	locked
	Feldfernschreiber, FF Schreiber	teletype printer
	Frequenz-Prüfer	frequency check
	Frequenzbereich	band switch
	Frequenzeinstellung	tuning control
	Frequenzkontrolle	frequency calibration

G	G.	counterpoise
	Grob-Einst.	coarse control
H	Hell	light
K	Kabelprüefung	cable test
	Kenngruppentafel	identifier group table
L	Laustärke	volume control
	Lautsprecher	loudspeaker
	Lose (Los)	unlocked
M	Mikrofon (Mikr.)	microphone
	Mit	with
	Mithoren	listen
N	Netzgleichnichter	power rectifier
	Nur Empfang	receive only
O	Ohne	without
	Ortsbespr.	local
R	Ruf	call
S	S.	transmitter, transmit
	S.-Aus	transmitter off
	S.-Bereit	transmitter standby
	Sammler	storage battery
	Schüsseltafel	coding table
	Senden	transmit
T	Taste	Morse key
	Teilstrich	tuning control dial
	Telefonie (Tn., Tfn.)	voice
	Telegr. ton.	tone
	Telegraphie (Tg., Tgr.)	continuous wave (CW)
	Tonseib 900	sound filter 900
U	Uithoren	listen
V	Verstarkung	amplification
Z	z. Empf.	to receiver
	z. Sender	to sender
	Zwischen Verkehr	telephone

CHAPTER 1

The 5-Watt Transmitter

I. DESCRIPTION. The 5-watt sender (5 W.S.) is a portable, general-purpose, medium-frequency, low-power transmitter capable of operation on CW (continuous wave) and voice communication. The set operates at a frequency range between 950-3150 kHz, divided into four categories (see Figure 1.2). Six different power sources are possible with the 5 W.S.: the pedal generator set types T5, T5a, T5a1, and generator sets types U5, U5a, and U5a1. A 12-volt vehicle storage battery must be used in conjunction with the transformers.



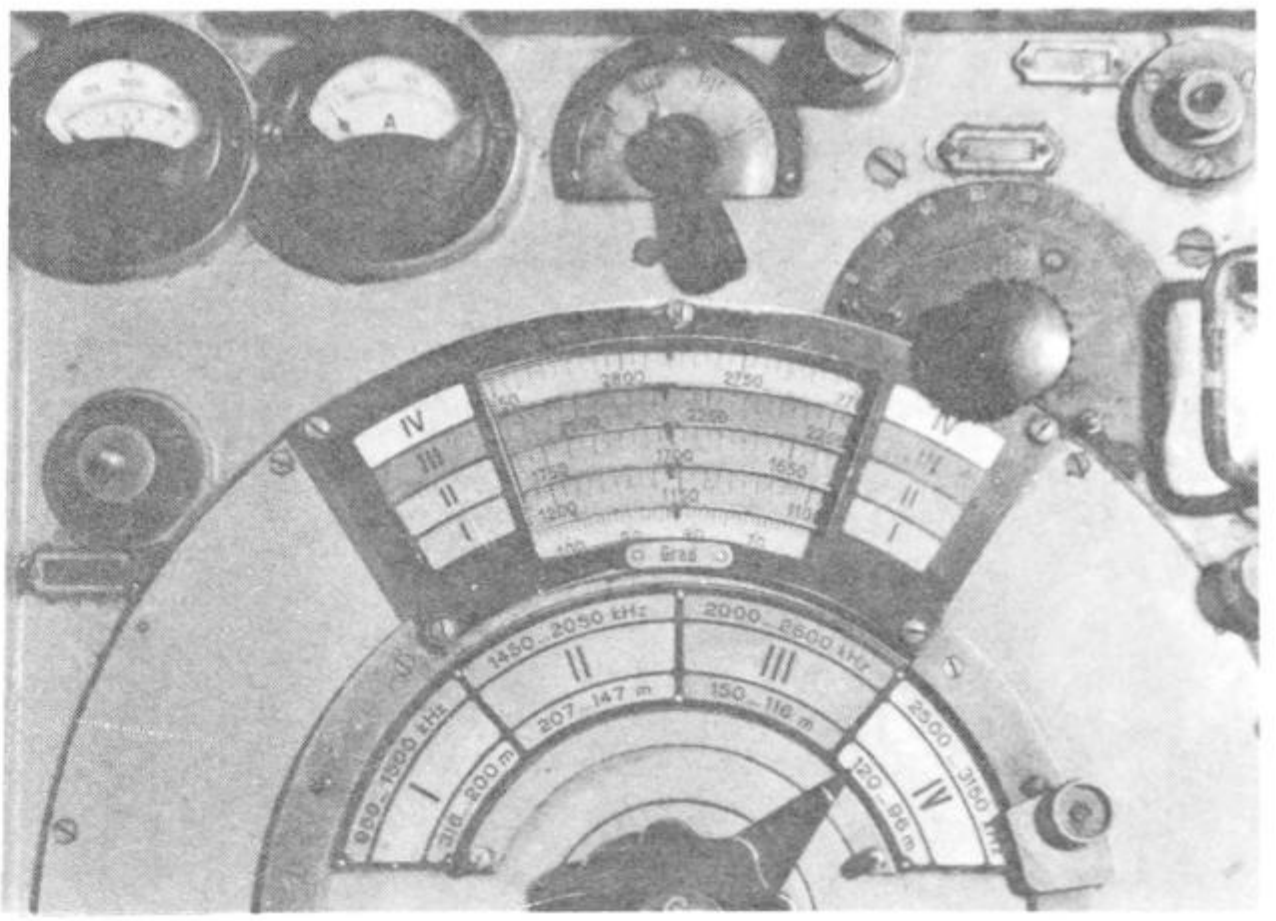


Figure 1.2 *Close-up view of the frequency range-setting positions and controls.*

Figure 1.1 *The 5-watt transmitter with hand microphone and Morse key installed.*

A. The following items make up the set:
   1. 1 hand microphone
   2. 1 Morse key
   3. 1 counterpoise cable (25 meters long)
   4. 1 antenna cable (15 meters long)
   5. 1 pedal generator type T5, T5a, T5a1 (see Figure 1.3)
   6. 1 generator type U5, U5a, U5a1 (see Figure 1.4)
   7. 1 carrying harness
   8. 5 antenna mast sections

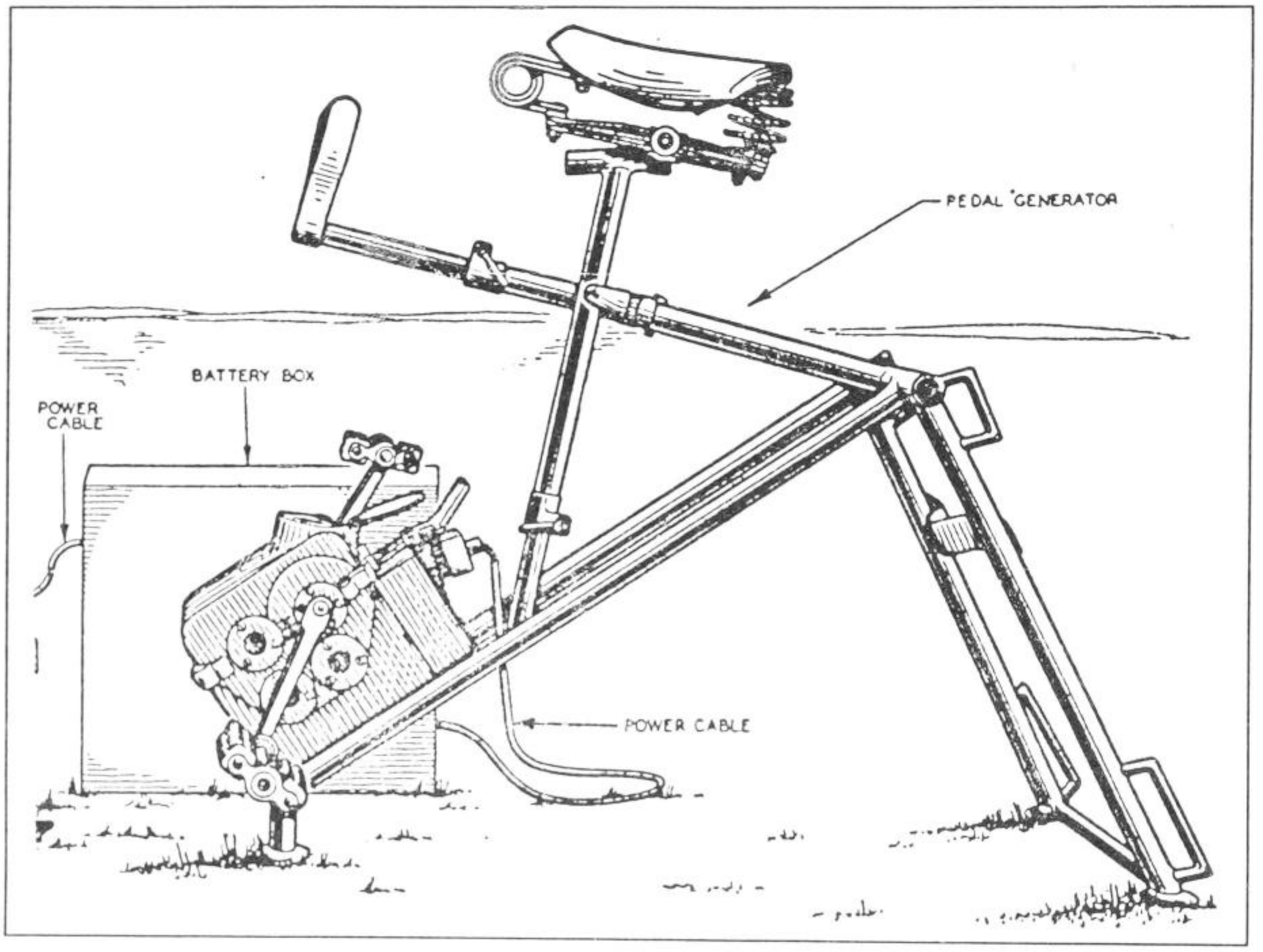


Figure 1.3 *Technical illustration of the T5 pedal generator.*

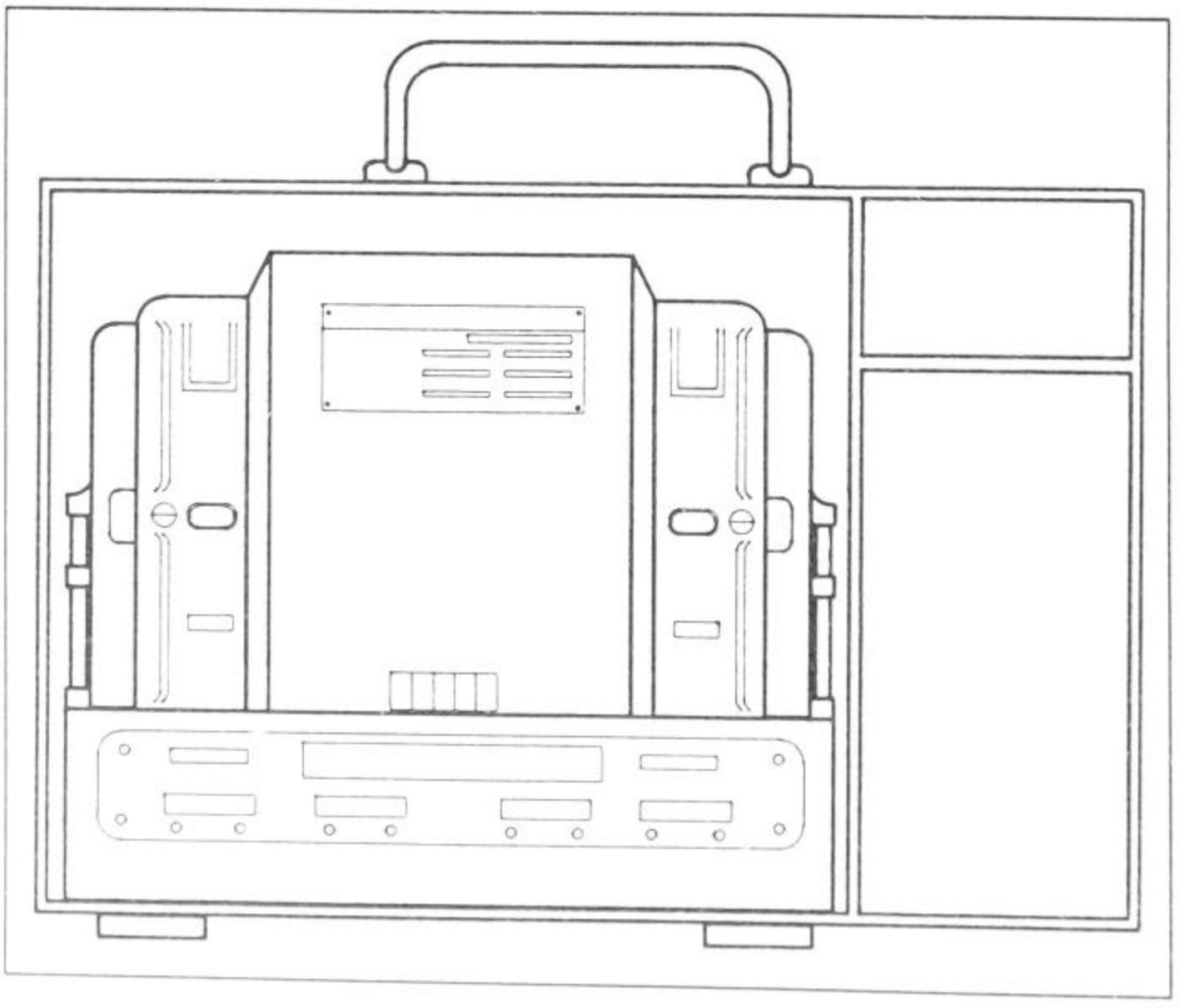


Figure 1.4 *Technical illustration of the U5 generator.*

B. The 5-watt transmitter is used together with portable receiver type b to make a small radio station.

II. PERFORMANCE DATA

Frequency range: 950-3150 kHz (in four band ranges)
Blue: 950-1500 kHz
Yellow: 1450-2050 kHz
Red: 2000-2600 kHz
White: 2500-3150 kHz

Preset frequencies: 2 mechanical dial stops on the dial mechanism

Type of signals emitted: CW, voice

Type of modulation: amplitude

Distance range
CW: 36 miles
voice: 10 miles

Antenna type
Ground: inverted L, with horizontal section approximately 15 meters long and a down lead of 4 meters
Vehicular: roof antenna

Dial graduations: kilocycles

Type of transmitter: master oscillator power amplifier (MOPA)

Tubes: 2 RS241 (Triodes) used as MOPA

Filament power requirements: 3.8 volts at 1.2 amperes

Weight: 21.5 kilograms

Height: 47.0 centimeters

Width: 36.6 centimeters

Depth: 20.5 centimeters without backrest, 24.0 centimeters with backrest

III. DESCRIPTION

A. The following plug and socket connections are installed on the instrument panel (See Figures 1.5, 1.6, and 1.7):
1. Antenna socket connection (upper right corner).
2. Antenna socket (upper left side).
3. Socket for counterpoise (lower left side). The connection panel for the operating voltages (left heater and right anode potential) are located at the lower right corner.

B. The plugs for the Morse key and microphone are located above the connection panel.

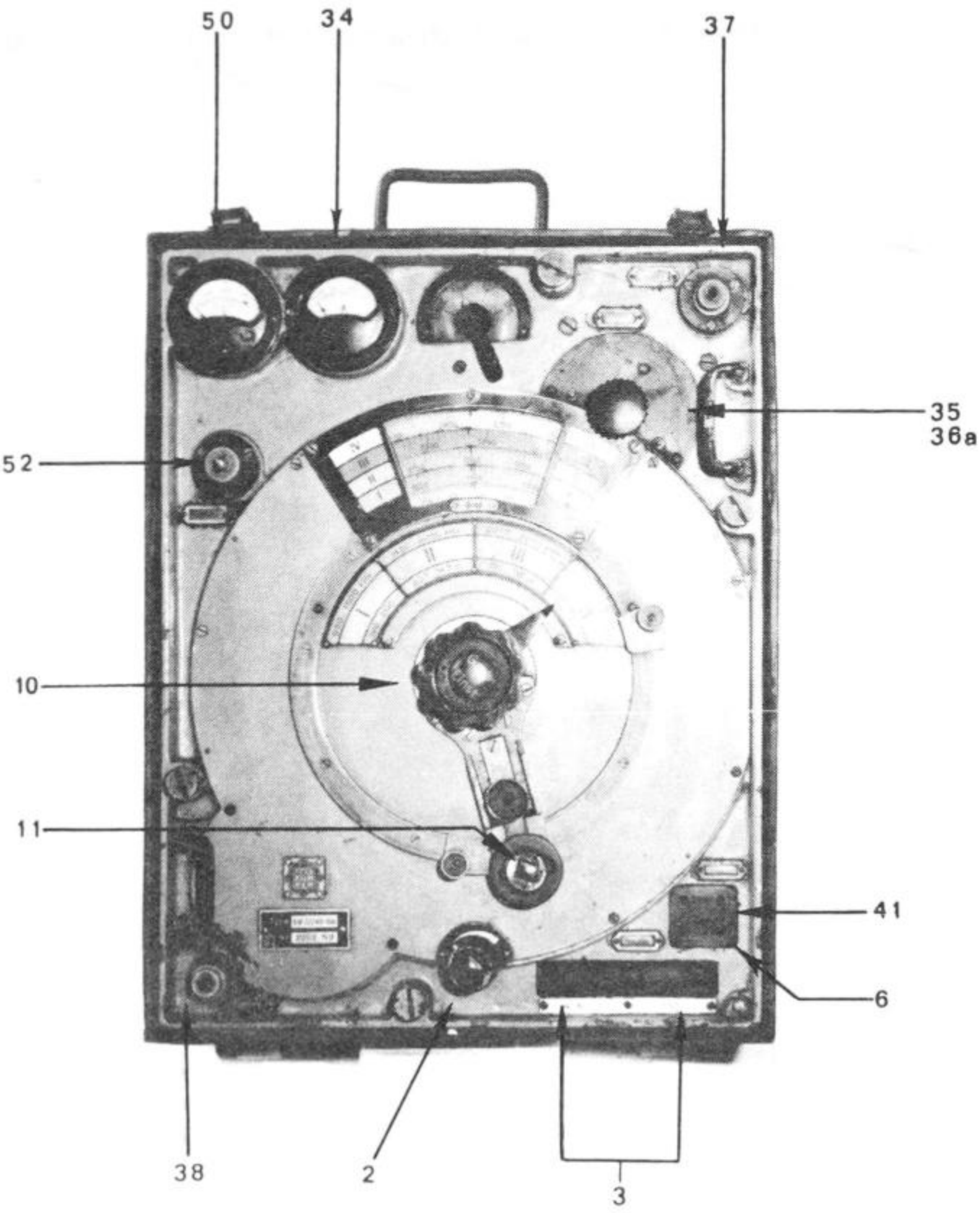


Figure 1.5 *Front view of the 5-watt transmitter. Clockwise from top left: voltage meter (50), frequency indicator (34), antenna connection socket (37), antenna micrometer adjustment lever (35, 36a), microphone plugs (41), Morse key plugs (6), heating anode potential connection plate (3), heat controller (2), ground plug (38), micrometer adjustment lever (11), coarse control switch (10), antenna plug (52).*

C. The 5-watt transmitter possesses the following measuring instruments:

1. The voltage meter (upper left corner of the instrument panel) has two measurement dials and one push button. The heating potential is measured on the lower dial (0-6 volts). The prescribed operating boltage is indicated by a red line at 3.8 bolts. By pressing the blue button, the boltage meter is in such a position that one can read the anode potential on the dial above. Some older sets are still equipped with a red button. The range of 300-330 volts is indicated in blue and shows the prescribed operating voltage.

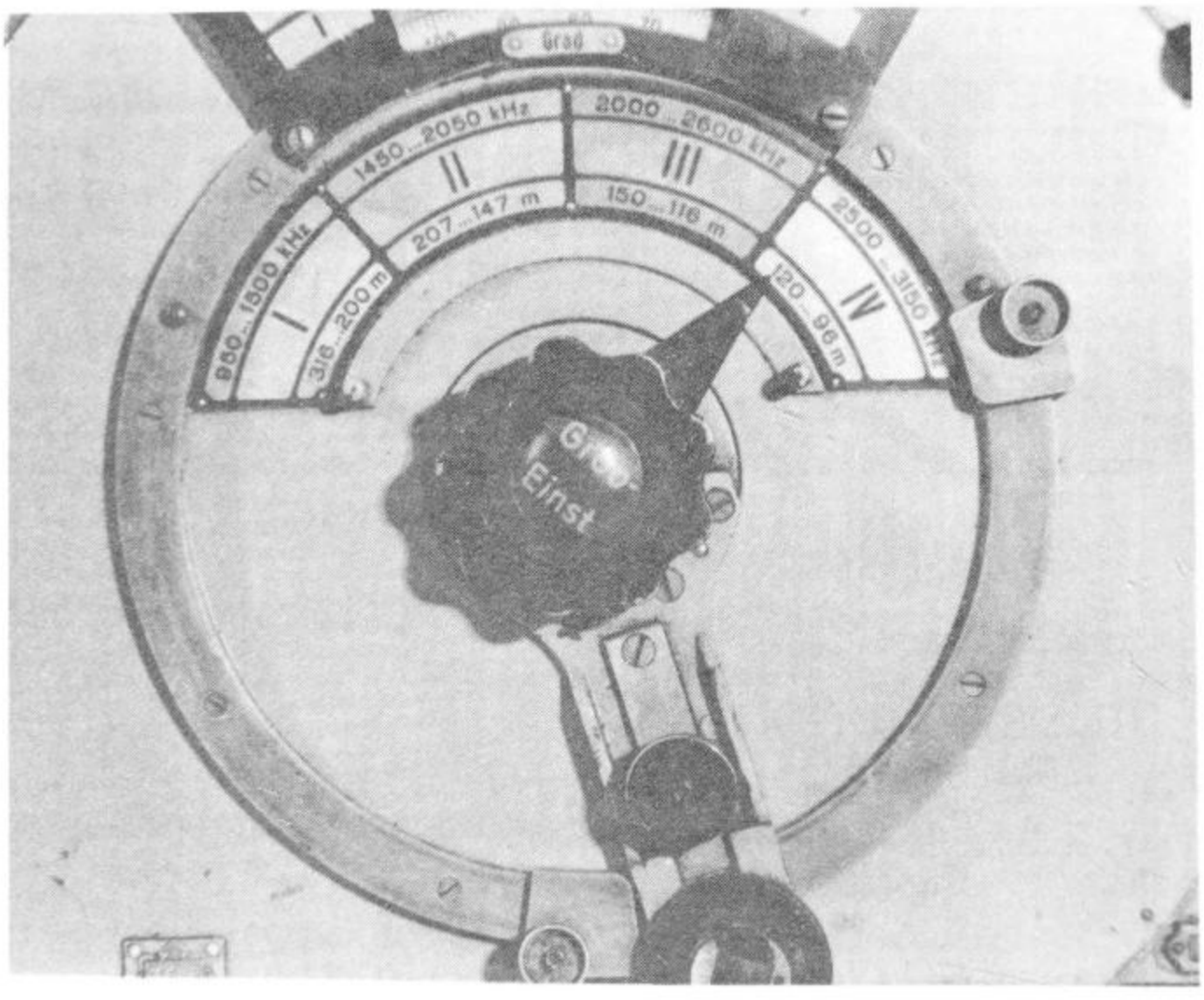


Figure 1.6 *Adjusting levers for the 5-watt transmitter: Grob-Einst. (coarse-control switch) and Fein-abstimmgriff (micrometer adjustment lever). Also visible are the movable stop pins along the circumference of the circle.*

2. The frequency indicator, adjacent to the voltage meter, is used to adjust the antenna circuit and has a scale from 0-0.5 amperes.

D. The adjusting levers (see Figure 1.6) of the 5-watt transmitter are:
1. Coarse control switch (same for regulation, high-frequency amplifier, and antenna).
2. Micrometer adjustment (only for control and high-frequency amplifier).
3. Antenna micrometer adjustment lever.
4. Heat control selector (the white arrow means that when you turn it towards its thicker end, the heater current increases).
5. Operation selector switch with the positions: "receive off-*telegraphie-telefonie.*"

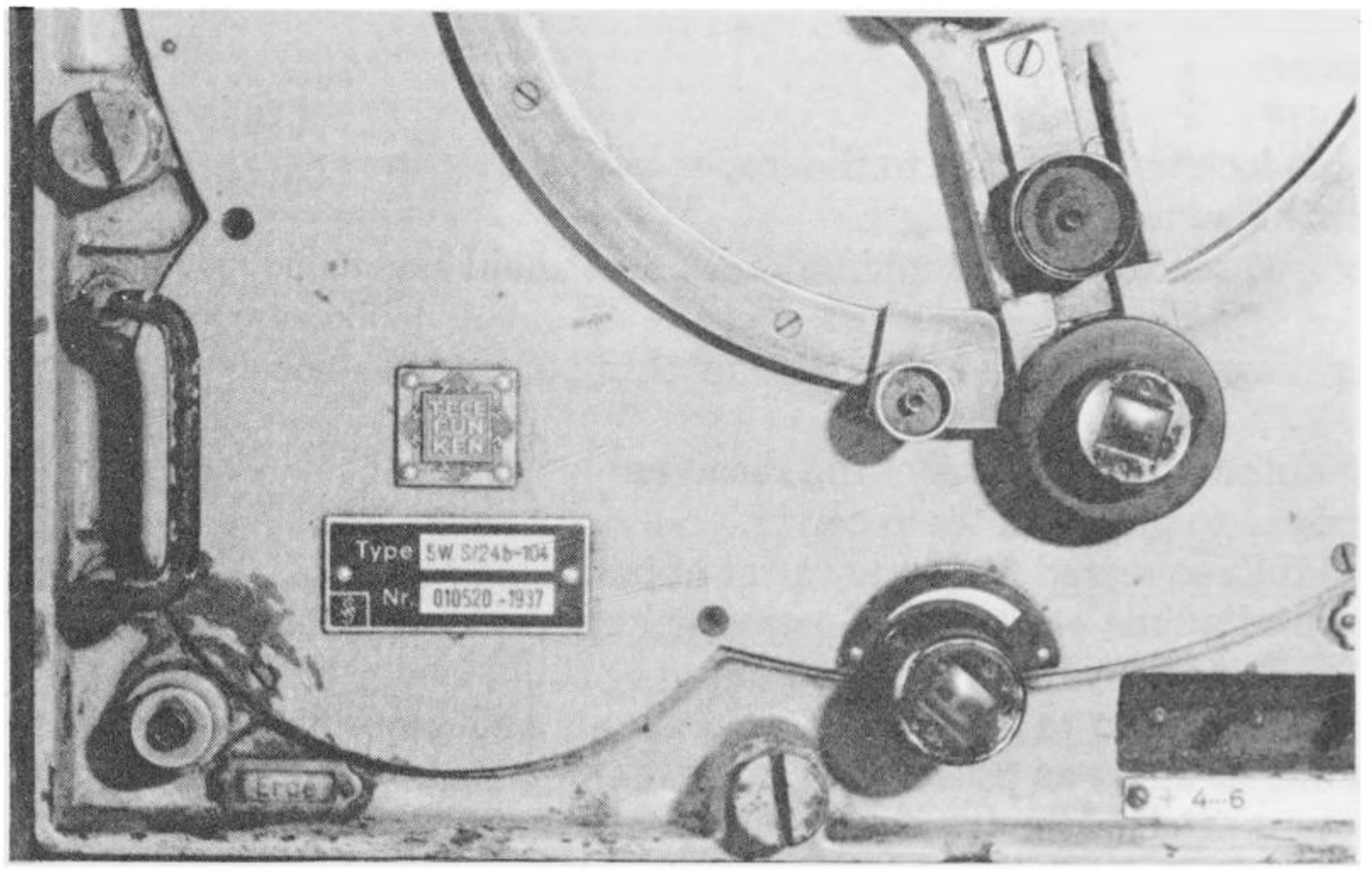


Figure 1.7 *Close-up view of the lower section of the instrument panel. From left to right: ground binding post, nameplate, heat control selector, fine adjustment lever.*

E. The coarse control switch has four positions, which are marked by the colors blue, yellow, red, and white. An indicator connected with the course control switch tells frequency range. The exact adjustment of the frequency can be read on the diagram, which is marked in the same color.

F. Two moveable stop pins allow the adjustment of two operating frequencies, which can therefore be changed quickly.

IV. OPERATION

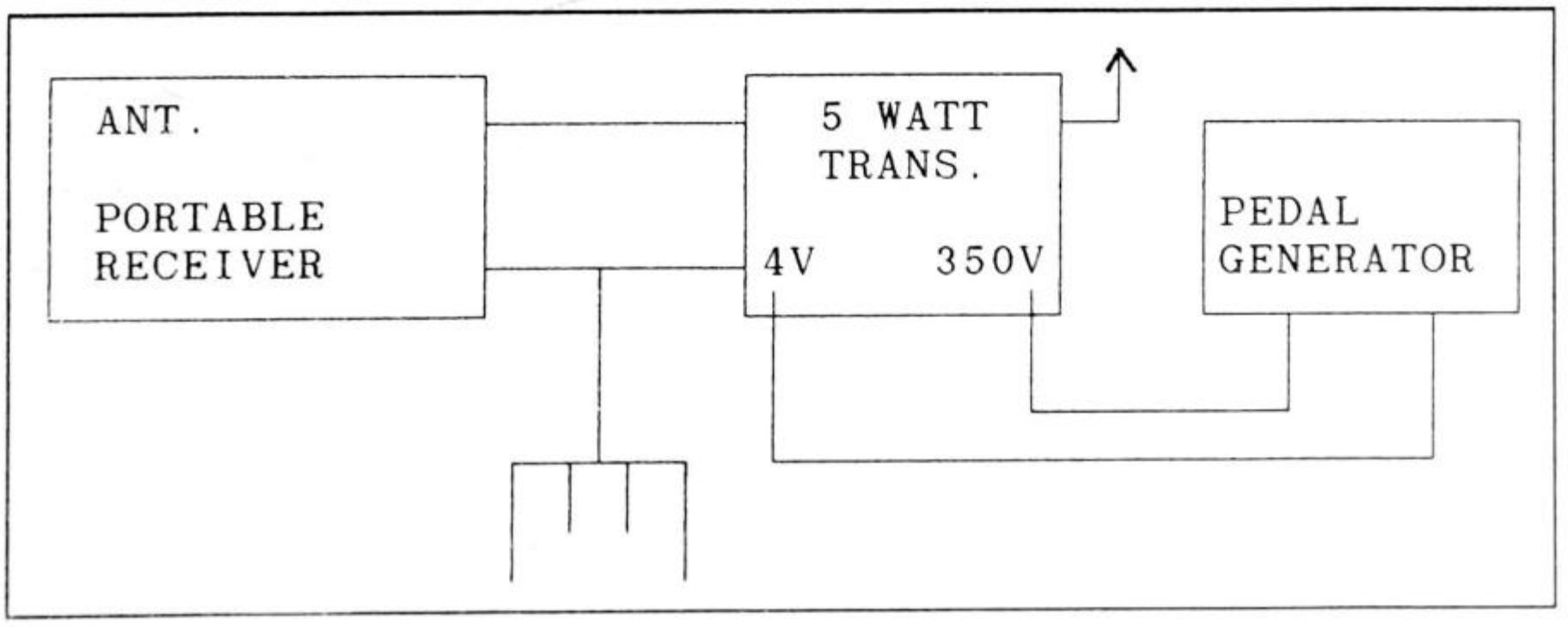


Figure 1.8 *Structure of a small radio station with pedal generator T5.*

There are six different power sources possible for the 5-watt transmitter: pedal generator T5, T5a, T5a1, generator U5, U5a, and U5a1.

A. Operating the 5-watt transmitter with the pedal generator T5.

1. Switch levers to primary position:
   a) Set operation selector switch to *Aus* (off).
   b) Turn heat controller to the left until stop.
   c) Place antenna micrometer adjustment to 0.
2. Make cable connection:
   a) Connect voltage meter V 400 to the sockets 350 of the pedal generator
   b) Connect anode potential cable to the socket 350 of the pedal generator and 350 of the transmitter.
3. Adjust operating frequency.
4. For CW operation:
   a) Fasten the stop pins to lock in frequency to the upper left and right.
   b) Adjust the coarse control switch accordingly.
   c) Adjust the operating frequency with the micrometer adjustment lever.

NOTE: The color of the frequency diagram is the same as the matching coarse control.

d) Insert the operating antenna in socket A of the receiver.
e) Connect the counterpoise to plug E of the receiver.
f) Adjust the receiver to the requested frequency after adjustment curve.
g) Turn on the receiver and adjust with the adjustment button at beat frequency of the adjustment transmitter.
h) Connect the simulated antenna to sockets *Ant.* (antenna) and ground on the transmitter with a connection line as short as possible.
i) Place operation selector switch of the transmitter on position *Tgr.* (CW).
j) Start pedalling the pedal generator and let the dial of the measuring instruments read continuously around the identification mark.
k) Adjust the heater potential to 3.8 volts (red line) with the heat controller. Push the button and adjust the micrometer adjustment lever of the transmitter frequency to beat its own receiver.
l) Push the button and adjust with the *Ant.-Fein* (antenna fine tuning) lever to the highest frequency of the oscillation indicator. Listen in the headphones for feedback. If this occurs, adjust the frequency beat using the micrometer adjustment lever on the transmitter.
m) Turn operation selector switch to *Aus.*
n) Turn off the simulated antenna.
o) Connect the receiver operating antenna to socket *Ant.* of the receiver.
p) Connect counterpoise to the transmitter ground socket.
q) Connect transmitter ground socket with socket E of the portable receiver.

NOTE: When working with a roof antenna, the ground plug of the receiver has to be connected directly to the counterpoise, which is mounted in the vehicle.

r) Connect *Empf.-Ant.* (receiver-antenna) on the transmitter with socket A of the Torn E.b portable receiver.
s) After adjusting the transmitter, adjust the receiver-to-receiver volume. Turn the micrometer adjustment of the receiver to the right or left out of the frequency beat until reception is possible.
5. For voice operation:

a) Adjust operating frequency as previously described and turn the operation selector switch to the *Tgr.* position.

b) Turn off the transmitter, place the operating selector knob to *Aus*, and let the pedal generator come to a full stop.

c) Adjust the operation selector switch to the transmitting position.

d) Start the pedal generator and maintain the prescribed voltage. Start transmitting and simultaneously adjust the *Ant.-Fein* lever to the maximum swing of the oscillation indicator.

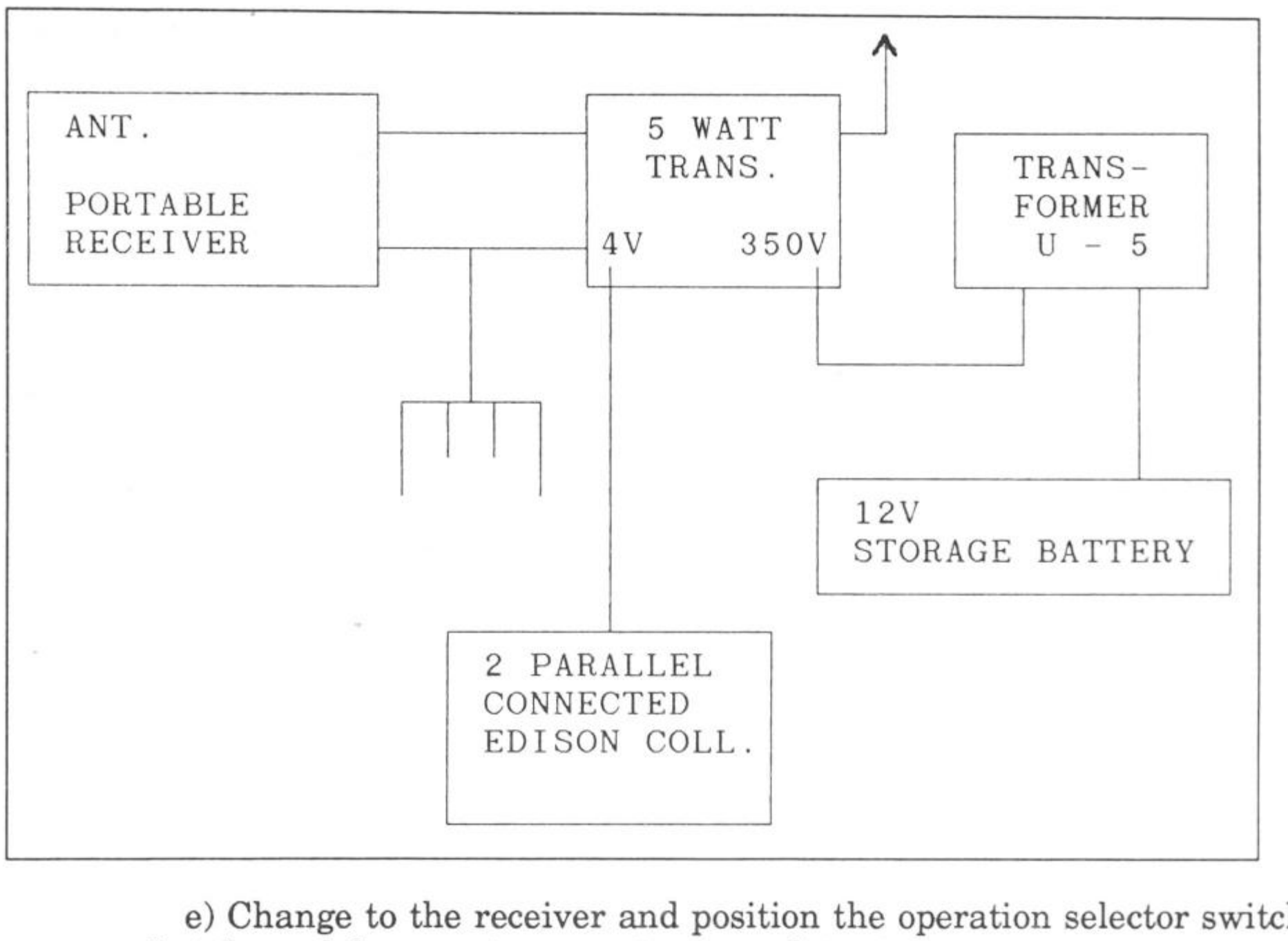


Figure 1.9 *Structure of a small radio station with generator set U5.*

e) Change to the receiver and position the operation selector switch to *Empf.* (receive). Let the pedal generator come to a complete stop.

B. Operating the 5-watt transmitter with the generator U5.

1. Set control levers to 0 and operator selector switch to *Aus.* Turn the heat control knob to the far left and set the micrometer adjustment lever to 0.
2. Generator:
   a) Turn both switches on the generator to *Aus*.
   b) Turn the regulating resistance switch to the left.
   c) Connect the cable connections. The cable connection of the 12-volt sockets on the generator has to be connected to the operating battery or to the 15-volt socket of the charger set B or C. Connect the anode potential cable to sockets 330 of the transformer and 350 of the transmitter. Connect the tester current cable to the 4-volt socket of the transmitter and to two parallel-connected Edison collectors 4.8 NC10. Connect the button with the "push-button" socket of the transmitter. In addition, if *telefonie* (voice) is requested, connect the microphone with the "microphone" socket on the transmitter.
3. Adjust operation frequency.
4. For CW operation:
   a) Affix stoppers to lock in the frequency at the upper left and right.
   b) Adjust the coarse adjustment switch of the operating frequency accordingly.
   c) Adjust the operating frequency with the micrometer adjustment lever.

NOTE: The color of the frequency diagram is the same as the matching coarse adjustment.

d) Plug the operating antenna in socket A of the receiver. Connect the counterpoise to socket E of the receiver. Adjust the receiver to the requested frequency using adjustment curve.

e) Turn on the receiver and adjust the beat frequency of the transmitter.

NOTE: Keep the antenna connection as loose as possible! After adjustment, no temporary change can be made. Repeat the adjustment only if necessary.

f) Connect the simulated antenna to socket *Ant.* and ground of the transmitter with connection cable. Keep the line as short as possible.

g) Turn the operation selector switch on the transmitter to *Tgr.*

h) Adjust heater potential to 3.8 volts (red line) with the heat control switch on the generator:

(1) Low voltage switch to "on."

(2) Anode potential switch to "on."

(3) Adjust the transformer operating voltage with regulating resistance to 12 volts.

i) Push the white button on the transmitter and adjust the receiver with the micrometer adjustment lever on the transmitter to the belt frequency (tuning in). Indicate the found adjustment by a stopper for the frequency marking.

j) Press the button and adjust for maximum oscillation with lever *Ant.-Fein.* Listen in the headphones for feedback of the control circuit (i.e., change of beat frequency). If this occurs, make minor adjustments using the micrometer adjustment lever.

k) Set the operation selector switch to *Aus.*

l) Connect the operating antenna on the receiver to socket *Ant.* on the transmitter. Connect counterpoise to the "ground" socket of the transmitter. Connect socket *Erde* on the transmitter with socket E on the portable receiver.

NOTE: When working with a roof antenna, the ground plug cable of the receiver has to be connected directly to the counterpoise cable, which is fixed in the vehicle or to the chassis.

m) Adjust the receiver to receiving volume. Turn the micrometer adjustment of the receiver to the right or left out of the beat frequency until *telegraphie* (CW) reception is possible.

5. For voice operation:

a) Adjust operating frequency as previously described.

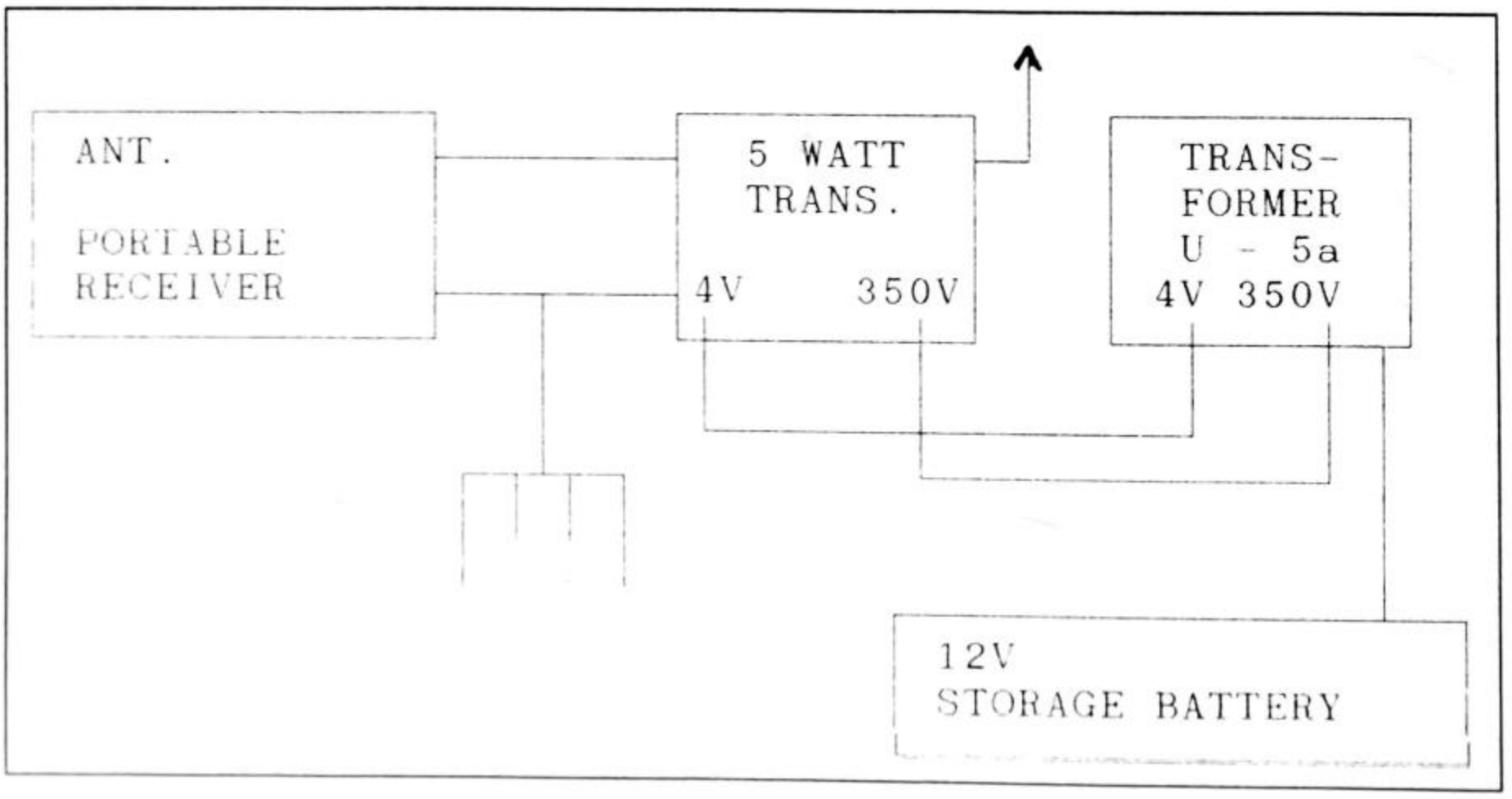


***Figure 1.10** Structure of a small radio station with generator set U5a.*

b) Set the lower switch to the *Tfn.* (voice) position.

c) Set the low-voltage switch of the generator to "on." Press the microphone button and speak into the microphone. At the same time, readjust the oscillation indicator to maximum swing with the *Ant.-Fein* lever.

d) Set operation selector switch to *Empf.* on the receiver and place the low-voltage switch of the generator to *Aus.*

C. Operation of the 5-watt transmitter with generator U5a.

1. Set the control levers to 0. Set transmitter selector knob to *Aus.* Turn the heat control knob to the left. Set the antenna micrometer adjustment lever to 0. Move the generator switch to 0. Set the regulating resistance to the far left.

2. Make cable connections.

a) When operating the transformer with the collector, connect the collector cable to the pair of plugs of the transformer. Connect the receiver's heater cable to the right sockets on the transformer.

b) When operating the transformer with the charger, connect the charger's cable to the pair of plugs on the transformer. Connect the heater cable to the left sockets. Connect the anode potential cable to the 350-volt socket of the transformer and 350-volt socket of the transmitter. Connect the button with the button sockets of the transmitter. If *telefonie* operation is requested, connect the microphone with the socket marked "microphone" on the transmitter.

3. For CW operation:

a) Clamp stoppers to lock in on the frequency at the upper left and right.

b) Adjust the course adjustment switch according to the operation frequency.

c) Adjust the operation frequency with the micrometer adjustment lever.

NOTE: The color of the frequency diagram is the same as the color of the matching coarse adjustment.

d) Plug the operation antenna into socket A of the receiver. Connect the counterpoise to socket E at the receiver.

e) Adjust the receiver to the requested frequency after adjustment curve.

f) Turn on the receiver and adjust beat frequency of the transmitter with the adjustment switch.

g) Connect the simulated antenna with a connection cable to socket *Ant.* and *Erde* of the transmitter (keep the cable as short as possible).

h) Place the operation selector switch on the transmitter to *Tgr.*

i) Adjust heater potential to 3.8 volts (red line) with heat control.

j) Turn on the generator by setting switch to I, adjusting anode potential to 320 volts with the regulating resistance and readjusting heater potential to 3.8 volts with the heat control of the transmitter.

k) Press the button simultaneously while adjusting your receiver to beat frequency with the micrometer adjustment lever. Mark the adjustment by locking it in the frequency. Press the push-button and adjust to maximum oscillation of the oscillation indicator with lever *Ant.-Fein.* At the same time, listen in the headphones for feedback to the control circuit. If this occurs, make minor adjustments of the beat frequency using the micrometer adjustment lever on the transmitter while simultaneously pressing the button.

l) Set the operation selector switch to *Aus* and turn off the simulated antenna.

m) Connect the operating antenna of the receiver to socket *Ant.* of the transmitter. Connect the counterpoise to the "ground" socket on the transmitter. Attach "ground" socket on the transmitter to socket E on the portable receiver.

NOTE: When working with a roof antenna, the ground cable of the receiver has to be connected directly to the counterpoise cable, which is fastened in the vehicle or to the chassis.

n. Connect socket *Empf.-Ant.* on the transmitter with socket A on the portable receiver.

o. When the adjustment of the transmitter is made, adjust the receiver to receiving volume. Turn the micrometer adjustment of the receiver to the far right or left out of the beat frequency until reception is possible.

4. For voice operation:

a) Adjust operating frequency as previously described.

b) Turn off the transmitter operation selector switch.

c) Set the low voltage switch of the generator to 0.

d) Set the operation selector switch to either *Tgr.* or *Tfn.*

e) If separate antennas are used for the transmitter and receiver, then the receiver antenna is left in place and the transmitting antenna has to be connected instead of the simulated antenna once adjustment to frequency beat is obtained.

f) Place the low-voltage switch of the generator to I.

g) Start operation. Readjust oscillation immediately with the *Ant.-Fein* lever to maximize reading.

h) Switch over to reception, placing the operation selector switch to *Empf.* Set the low-voltage switch to 0.

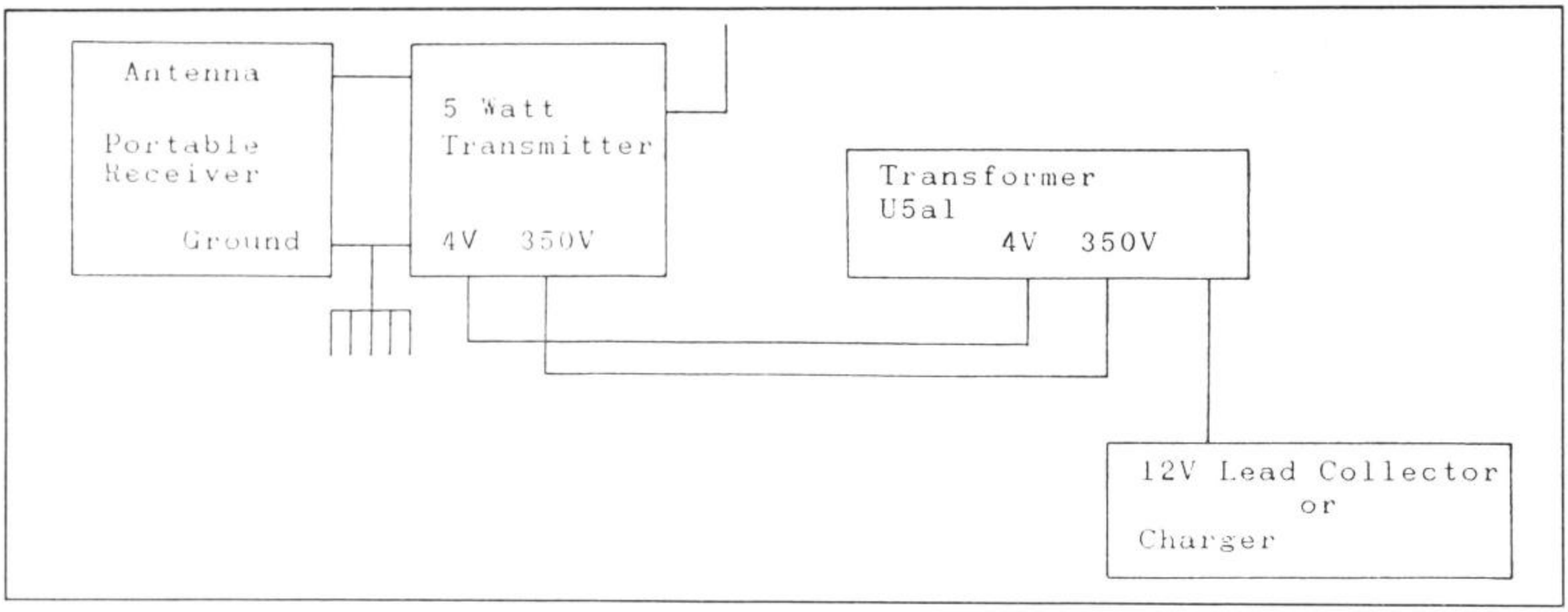


Figure 1.11 *Structure of a small radio station with generator set U5a1.*

D. Operating the 5-watt transmitter with the generator U5a1.

1. Set the control levers to 0. Set the operation switch to *Aus.* Set the heater control to the left. Place the antenna micrometer adjustment lever to 0. Turn the generator control resistance to the left until stop.

2. Make the cable connections. When the set is in operation with the collector, connect the collector cable to the pair of sockets of the transformer. Connect the heater cable of the transmitter to the right socket of the transformer.

3. When operating the transformer with the charger, connect the charger cable to the pair of sockets of the generator. Connect the heater cable to the left sockets of the generator. Connect the anode potential cable to the 350-volt sockets of the generator and to the 350-volt sockets of the transmitter. Connect the button with the "button" sockets of the transmitter. Adjust the operating frequency.

4. For CW operation:

a) Affix the stoppers to lock in frequency to the upper left and right.

b) Adjust the coarse adjustment switch to the operating frequency.
c) Adjust the operating frequency with the micrometer adjustment lever.

NOTE: The color of the frequency diagram is the same as the color of the matching coarse adjustment.

d) Plug the operating antenna into socket A of the receiver.
e) Connect counterpoise to socket E of the receiver.
f) Adjust the receiver to the desired frequency using adjustment curve.
g) Switch on the receiver and adjust frequency beat of the transmitter using the adjustment knob. Keep the antenna connection as long as possible.
h) Connect the simulated antenna to the *Ant.* and ground sockets of the transmitter with a connecting cable (keep cable length as short as possible).
i) Put the operation selector switch of the transmitter to *Tgr.*
j) Adjust control resistance of the generator to 320 volts.
k) Readjust heater potential at the transmitter to 3.8 volts.
l) Using the micrometer adjustment lever, adjust the frequency beat of the transmitter to the receiver.
m) Indicate the frequency marking adjustment using a stop pin.
n) Press the button and adjust the oscillation using the *Ant.-Fein* adjustment lever for maximum oscillation. Listen in the headphones for feedback of the control current. If this occurs, make minor adjustments using the micrometer adjustment lever.
o) Set the operation selector switch to *Aus* and turn off the simulated antenna.

NOTE: The generator starts independently due to a relay circuit. If separate antennas are used for the transmitter and receiver, then the receiver antenna is left in place and the transmitter antenna has to be connected instead of the simulated antenna after adjusting frequency beat.

p) Connect the "ground" socket of the transmitter to socket E of the portable receiver.

NOTE: When working with a roof antenna, the ground socket of the receiver has to be connected directly to the counterpoise cable, which is firmly mounted in the vehicle.

q) Connect socket *Empf.-Ant.* of the transmitter to socket A of the portable receiver.
r) After adjustments of the transmitter are complete, adjust the receiver volume. Turn the micrometer adjustment of the receiver to the right or left out of the frequency beat until reception is made.

5. For voice operation:
a) Adjust operating frequency as previously described.
b) Once transmitter adjustment is completed, leave the receiver adjustment unchanged and adjust the feedback to just before the operation point.
c) Turn off the transmitter.
d) To transmit, adjust with the operation selector switch to the *Tfn.* position. Press the microphone and speak into the mouthpiece. Readjust the oscillation immediately using the *Ant.-Fein* lever for maximum reading.

V. MAINTENANCE

A. Field Tests and Error Removal.

1. The connected parts (sockets and plugs) for the antenna, ground headphone, microphone, and energy sources have to be kept clean.

2. Tubes have to be examined at regular intervals (about every three months) for cleanliness and secure connection contacts.
3. If the set has not been used for some time, you have to turn the operation selector switch and the coarse control switch several times to different positions in order to brush the contacts clean.
4. The 5-watt transmitter has to always be kept dry and clean. If the transmitter gets wet inside, it has to be removed from the box, rubbed carefully with a clean, soft cloth, and dried at room temperature for some time. Concentrated and direct heat has to be avoided at all times or the insulation will be damaged. Do not put the set near ovens, open fire, electrical heaters, etc.!

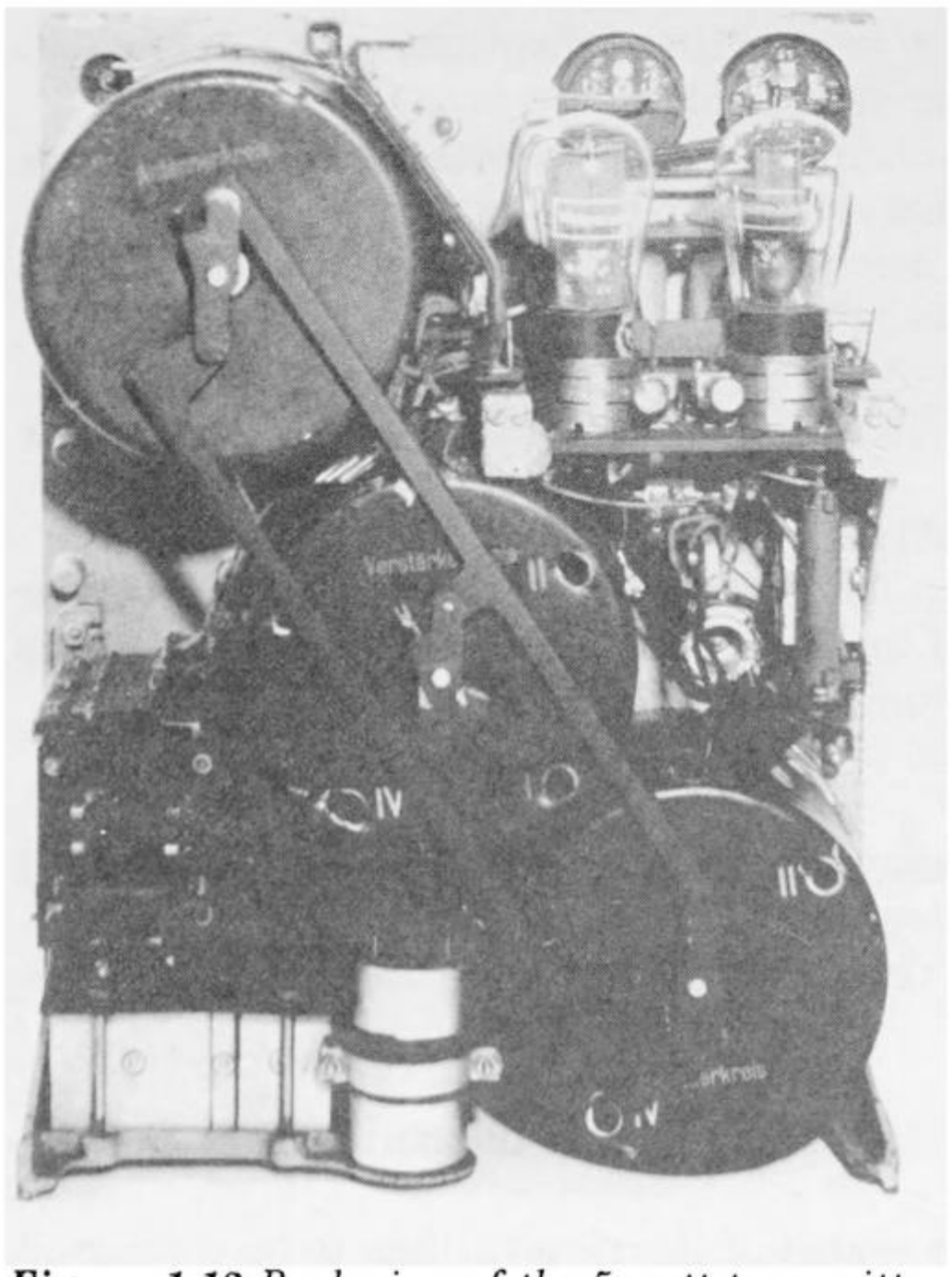


Figure 1.12 *Back view of the 5-watt transmitter removed from its case.*

B. Troubleshooting.

NOTE: For each disturbance, search for the cause on the outside first.

1. Oscillation indicator shows no or slight swing:
   a) Check the antenna and ground connection.
   b) Check the heater and anode potential. If one of these potentials is missing, check the cables for loose connections or damage.
   c) If there are potentials (tensions), then adjust the transmitter again using a simulated antenna.
   d) If it results in a good adjustment, then the error is located in the antenna or the counterweight. If no adjustment is reached or the swing is too small, then check the button or exchange tubes one after the other. Try to test each one in succession. If the error still occurs, turn the set in to higher-echelon direct support maintenance.
2. Unclear speech:
   a) Shake the microphone.
   b) Check the microphone cable and plug for a loose connection.
   c) Exchange the microphone capsule.
   d) If speech is still poor on various frequencies (can only be determined with two receivers because error could be in the receiver), then the electrolyte condensator is damaged.
3. Bad key indication:
   a) Check contacts of the buttons, adjust the lift of the buttons, and check energy-source collectors.
   b) If the error is not yet found during the test process, test the set by checking all cables, contacts, and connecting parts; check for loose contacts.
4. Further errors:
   a) Check for other interruptions or a short circuit in the transmitter, especially a faultless insulation, touch blank cables, wire breakages, badly soldered points, loose screws, dirty contacts, or bent or slack contact springs at plugs and resistance clamps. Careful! Do not bend cables; otherwise the adjustment may be altered.

Figure 1.13 *The pedal generator set T5 in operation.*

b) If the error is not found, then search with a continuity tester (field measuring box):

(1) Take out tubes.

(2) Follow along all cables according to the installation circuit diagrams (found in the lid of the cover plate) and attempt to localize the error. Pay attention to junctions because they can often fake an insulation error!

(3) Check resistance for interruptions or burns.

(4) Check condensators for a short circuit. Pay attention to correct poling of the established test voltage at the electrolyte condensator. If the poling is correct, the measuring instrument shows oscillation.

CHAPTER 2

The 15-Watt Transceiver

I. DESCRIPTION

A. Transceiver. The 15-watt transceiver (Figure 2.1) is a portable transmitter receiver capable of transmitting *Telegraphie* (CW), or *Telefonie* (voice) amplitude-modulated signals. The set, abbreviated 15 W.S.E (15-watt transmitter E), was primarily used by artillery units and was found at battery fire direction-control centers and forward observation posts. The 15 W.S.E. has provisions for installing the *Feldfernschreiber* (teletype printer) and *Fernbesprechung* (remote) equipment. The set is housed in a rainproof and dustproof sheet metal case, with the front cover held in place by four clasps.

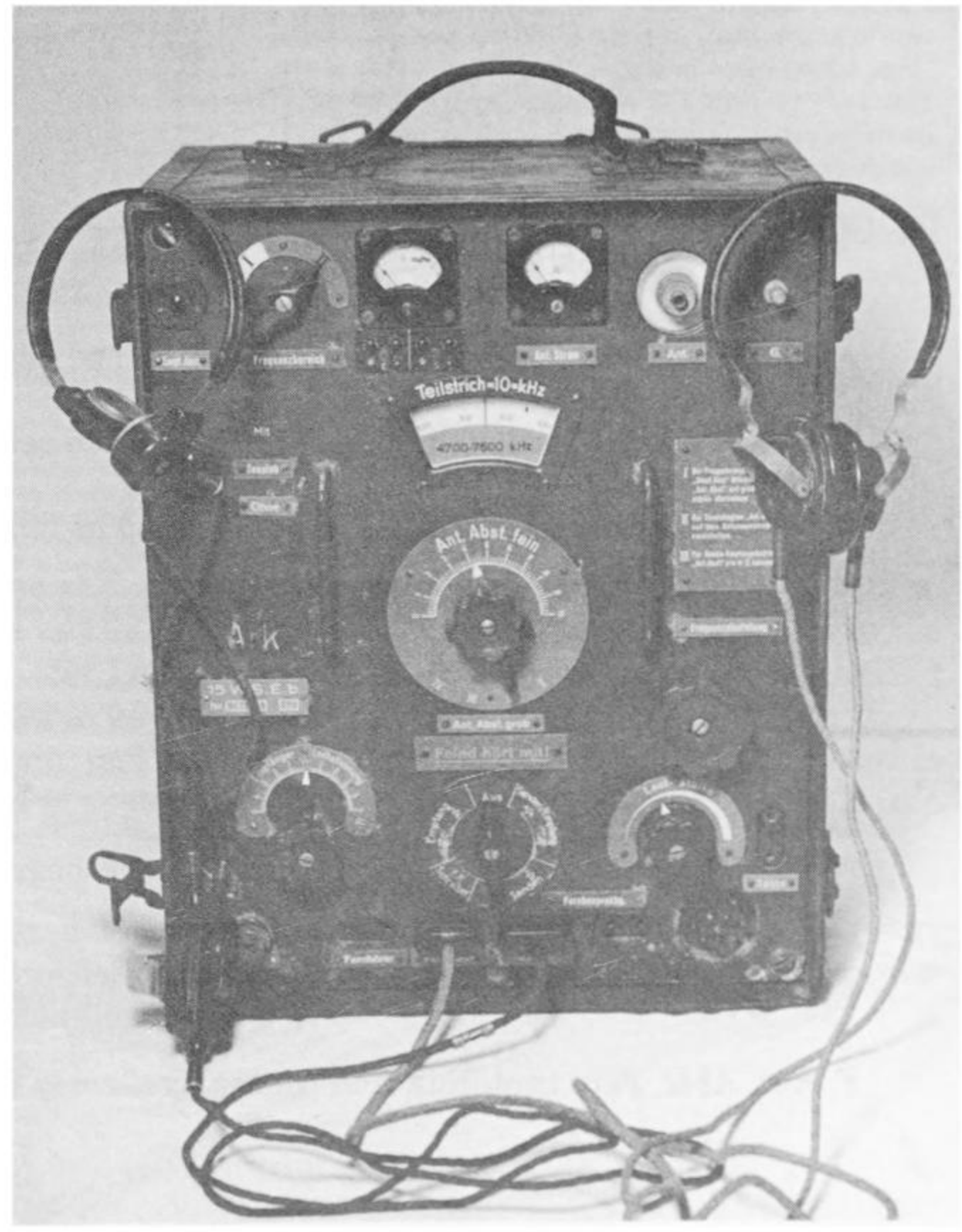


Figure 2.1 *The 15-watt transceiver (15 W.S.E.)*

B. Power Source. Pedal generator type 15A and rectifier with storage battery 2.4NC 58, and 12-volt storage battery with dynamotor type 15A.

II. PERFORMANCE DATA. The following table lists the performance data of the set.

Frequency Range
Band I: 3,000-4,700 kHz.
Band II: 4,700-7,500 kHz.

Type of signal: CW and voice

Distance range
CW: approximately 60 miles
voice: approximately 20 miles

Type of transmitter: master oscillator-power amplifier (MOPA)

Number of tubes: 12
transmitter: 3 RL 4.8 P15
1 RV 2.4 P700
receiver: 8 2.4 P700

Power output: approximately 15 watts

Antenna type
Ground: hi-rod with counterpoise
Vehicular: vehicle roof or rod

Power supply: type 15A pedal generator with rectifier, and dynomotor type 15A with 12-volt vehicle storage battery

III. CONTROLS. A brief description of the controls and their functions is shown in Figures 2.2 and 2.3.

A. The *Frequenzeinstellung* (tuning control) operates the dial and tuning capacitors.

B. The *Frequenzbereich* (band switch) is used to select either of the two frequency ranges.

C. The eight-position main switch is labelled as follows:
1. *Aus* (off).
2. *Senden Tg./Empfang Tn.* (transmit CW, receive voice).
3. *Senden Tg. Tn.* (transmit CW, voice).
4. *FF Schreiber* (field teletype printer).
5. *Empfang Tn. Tg.* (receive voice, CW).

D. *Lautstärke* (volume control) is used to adjust the volume. The white band printed across the top of the control knob indicates the degree of audibility and is adjusted from faint (left) to loud (right).

E. *Empfanger Nachstimmung* (receiver fine tuning) is used to tune in the incoming signal.

F. *Ant. Abst. Fein* (antenna fine tuning) control is for antenna tuning.

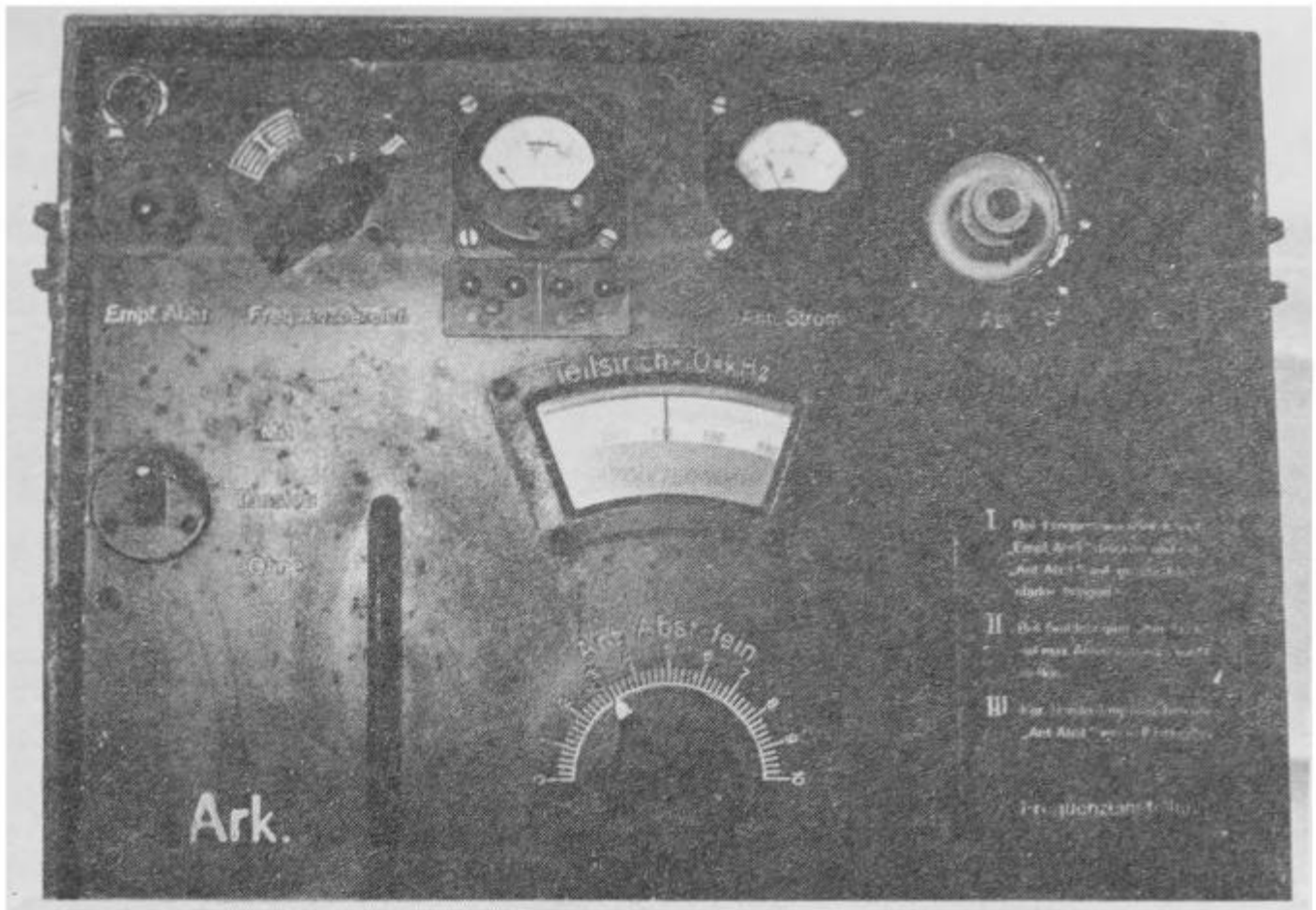


Figure 2.2 *Top section of the set. From left to right: Empf. Abst. (receiver tuning button), Frequenzbereich (band switch), voltmeter, antenna meter, antenna connection, Mit-Tonsieb-Ohne (filter switch), dial frequency adjustment, Ant. Abst. Fein. (antenna fine tuning).*

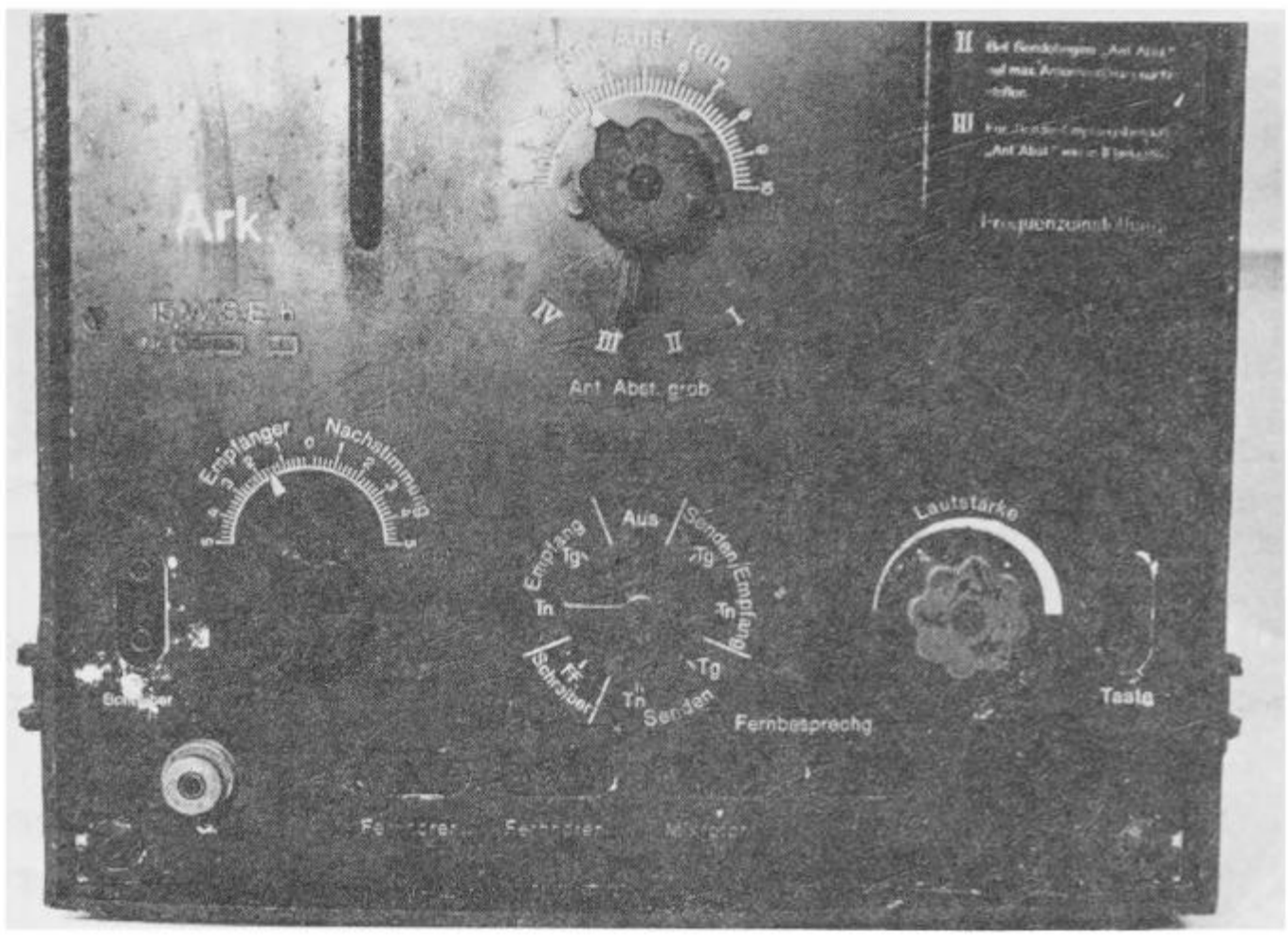


Figure 2.3 *Lower section of the set. From left to right: nameplate, Ant. Abst. Gross (antenna coarse tuning), Frequenzeinstellung (tuning control), FF Schreiber (teletype printer input jack), Empfanger Nachstimmung (receiver fine tuning), main switch, Lautstärke (volume control), Taste (Morse key input jack), G. (counterpoise connection), Fernhorer (headphone jack), Mikrofon (microphone jack), Fernbesprechg (remote input jacks plug holder).*

G. *Ant. Abst. Gross* (antenna coarse tuning) control is a four-position switch for selecting antenna-series tuning capacitors.

IV. INSTALLATION

A. Transceiver. Remove the front cover and set the main power switch to the *Aus* position. Connect the antenna lead-in to the antenna socket. Connect the counterpoise cable to the counterpoise binding post. Plug the hand microphone into the input jack labelled *Mikrofon* (microphone). Plug the Morse key into the input jack labelled *Taste* (Morse key). Plug the headphones into the input jack labelled *Fernhorer* (headphones). The set is designed so two headphones can be used (see Figure 2.1). Plug the power input cable into the power receptacle.

B. Power Supply. The set may be operated with a pedal generator set type 15A; a 12-volt storage battery with dynamotor type 15A is used for vehicle configuration. Detailed information on installation is currently unavailable.

C. Antenna.

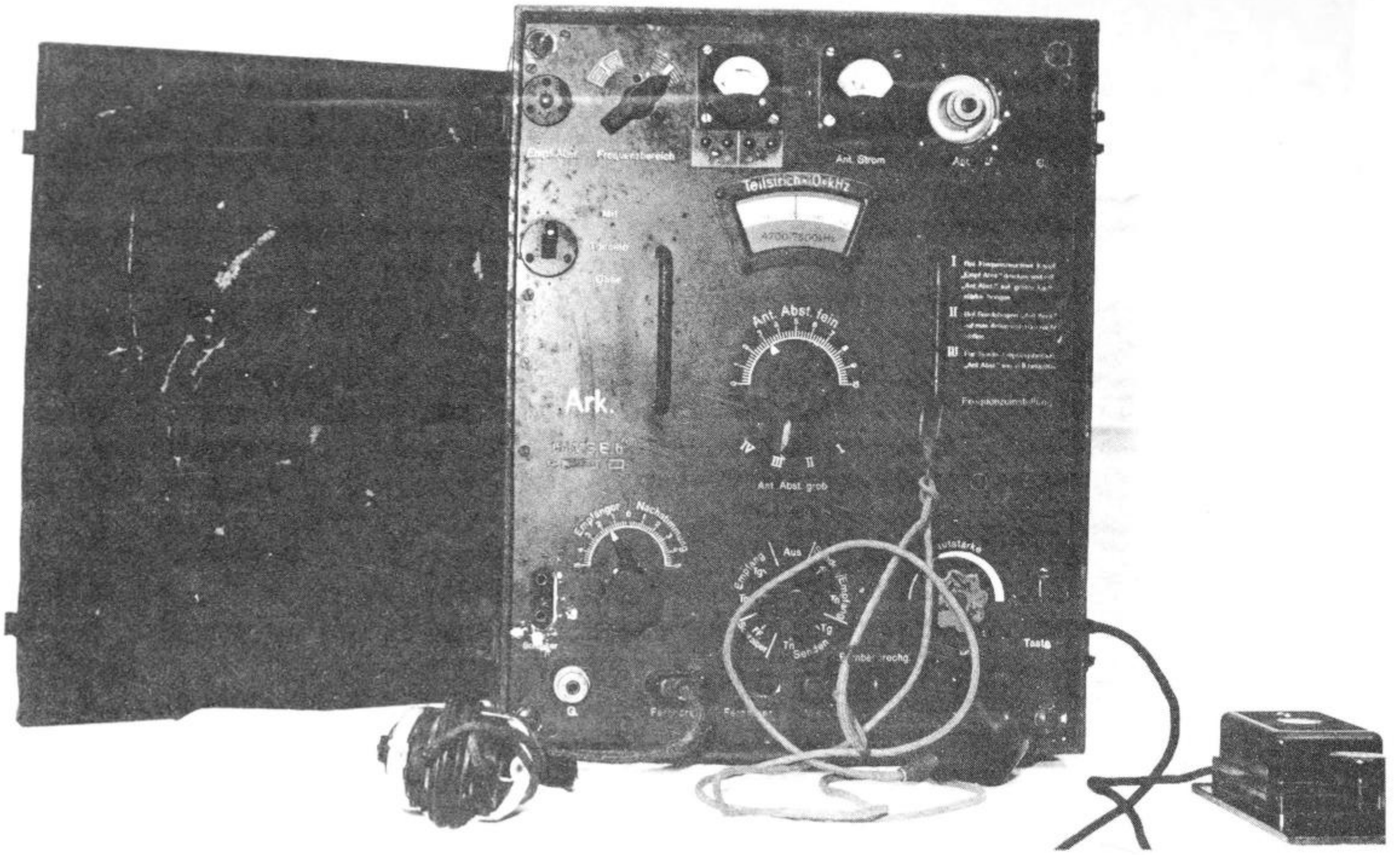


Figure 2.4 *The 15 W.S.E. with accessories.*

1. When used in a vehicle, install the vehicle antenna and connect the lead-in to the antenna connection socket. Connect a ground wire to the counterpoise binding post and securely attach the loose end to the vehicle chassis.
2. Use a vertical rod antenna of a long wire antenna when the set is used for ground operation. Connect the lead-in as in C1 above. Connect the counterpoise cable to the counterpoise binding post and spread the cable out on the ground.

V. OPERATION

A. Tuning.

1. After the set has been installed as directed in IV above, turn the knob marked *Frequenzbereich* to the desired band setting. Turn the dial marked *Frequenzeinstellung* to the selected frequency. Frequency in kHz = dial reading x 10.
2. Set the main switch to *Tg.* and wait approximately one minute for the tubes to heat up.
3. Check the voltage by reading the voltmeter located at the top center of the instrument panel. The filament voltage should be at 12 volts as indicated by the red mark on the meter dial. The plate voltage should be within the blue mark. To check the plate voltage, press the blue button on the voltmeter.
4. Check the antenna strength by placing the main switch to the *Empfang* (receive) position and adjust the strength of the tone by using the *Empfanger Nachstimmung* control in conjunction with the *Ant. Abst. Gross*. The antenna fine-tuning control should be adjusted for the maximum meter reading.

B. CW Operation.

1. For CW operation, set the *Frequenzbereich* control and tuning dial to the desired frequency.

2. Set the main switch to *Tg.* in either the *Senden-Empfang* (transmit-receive) or *Senden* range. Wait one minute for the tubes to heat.
3. Press the Morse key and adjust the *Ant. Abst. Fein* control for maximum output.

C. Voice Operation.
1. For voice operation, set the frequency as described in B above.
2. Set the main switch to *Tn.* in either the *Senden-Empfang* or *Senden* position.
3. Press the microphone button and observe the antenna meter. A slight upward swing of the pointer indicates modulation is taking place.

D. Receiving.
1. Tune the frequency as previously described.
2. Set the main switch to the *Empfang* or *Senden-Empfang* position.
3. Key the microphone or Morse key and listen for the tone feedback in the headphones. Adjust the strength of the receiver using the *Empfanger Nachstimmung* control.

E. Teletype Printer.
1. Install the equipment as previously described.
2. Place the main switch to the *FF Schreiber* position.
3. Connect the cable from the input jack of the teletype printer to the receiver receptacle on the amplifier unit of the teletype printer.
4. Begin operating the teletype printer.

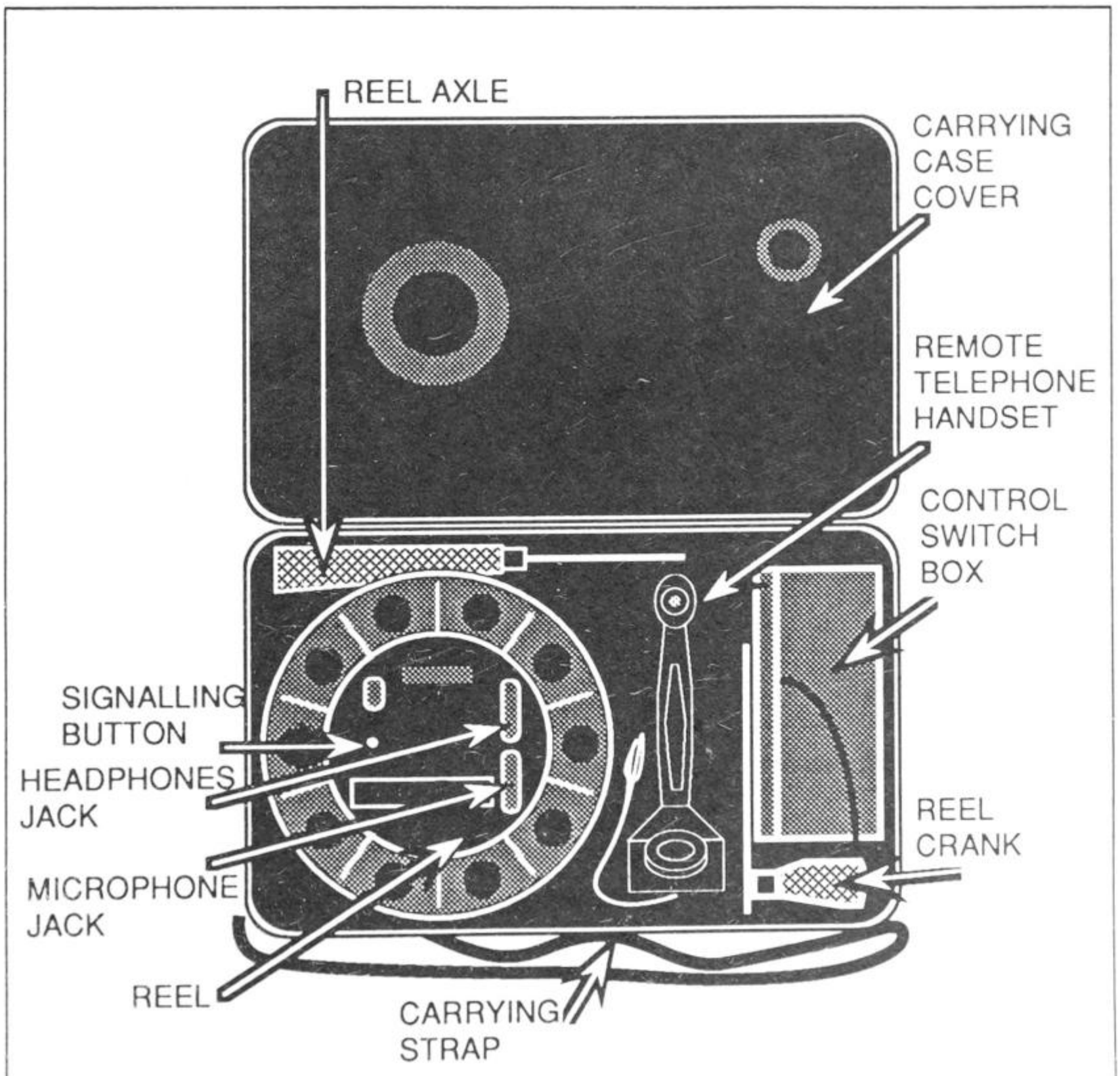


Figure 2.5 *Remote operation equipment.*

NOTE: Frequency adjustment is common to the transmitter and receiver, which are always on the same frequency. Receiver fine tuning must always be done by the control knob *Empfanger Nachstimmung*, never by the *Frequenzeinstellung* knob. When tuning the transmitter either to the *Tg.* or *Tn.* position, the transmitter must first be activated by pressing the microphone button or Morse key. The main switch should be placed

in *Senden Tg.* or *Senden Tn.* to save current by shutting off the receiver during periods of long reception. The transmitter can be shut down by setting the main switch to the *Empfang Tn.* or *Tg.* position. As a security measure, it is possible to tune the antenna without causing it to radiate.

VI. REMOTE OPERATION

A. General. The set includes a case that contains the following equipment for remote voice operation (see Figure 2.5).
1. Reel containing 50 meters (165 feet) of cable.
2. Reel axle for winding and unwinding reel.
3. Reel crank used in conjunction with reel axle.
4. Control switch box used at transmitter location.
5. Remote telephone handset.

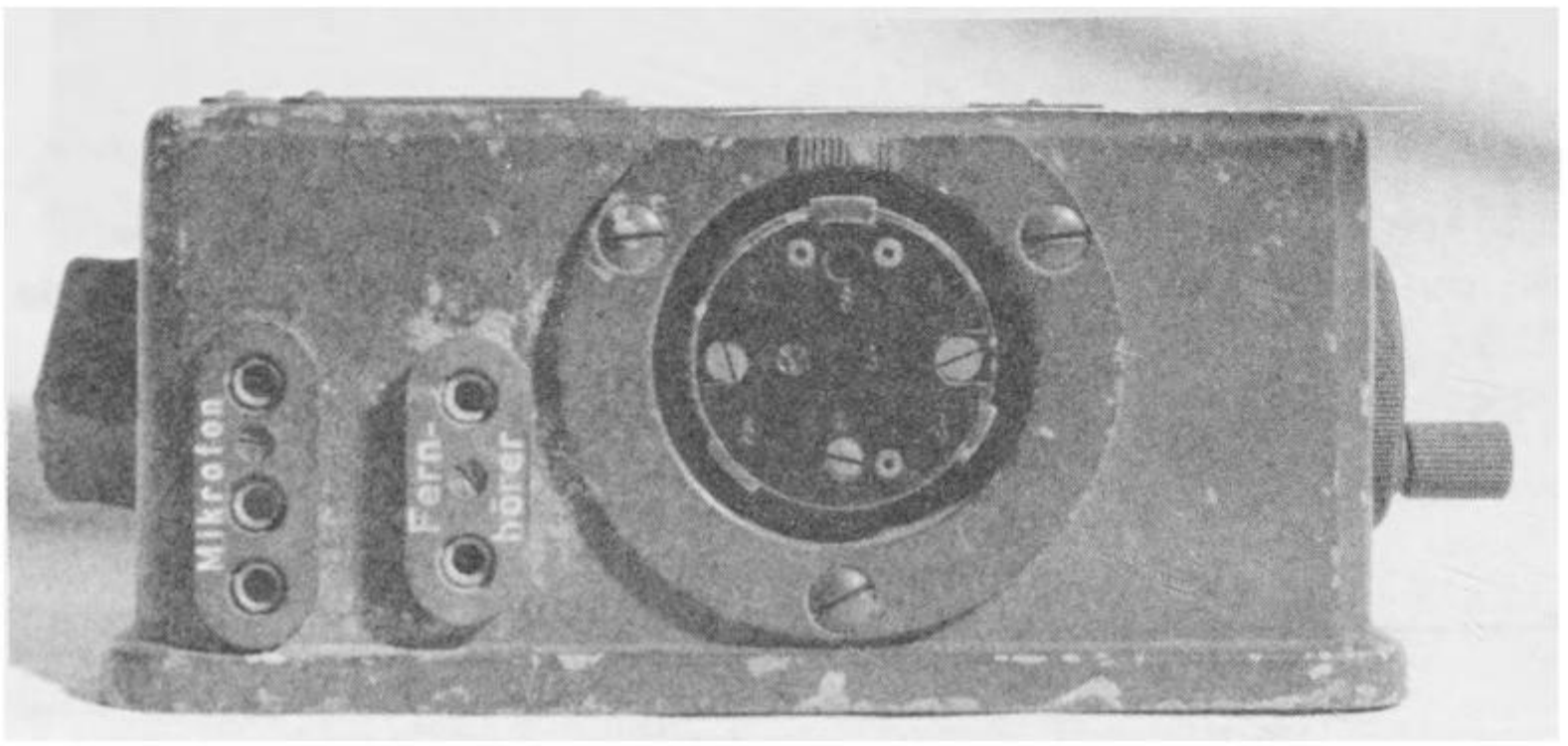


***Figure 2.6** Right side of the remote control switch box. From left to right: microphone jack, Morse key jack, plug receptacle.*

B. Installation.
1. The control switch box is located at the transceiver and is connected to the input jack on the set marked *Fernbesprechung* by the contact plug on the switch box.
2. Plug the microphone (hand or throat type) into the jack marked *Mikrofon* on the switch box (see Figure 2.6).
3. Plug the headset into the jack marked *Fernhorer* on the switch box.
4. Plug the cable from the reel into the five-contact plug provided on the control switch box.
5. Using the reel axle and crank, unwind the cable on the reel and place the reel at the remote location.
6. Plug the three-contact plug of the remote telephone handset into the jack on the reel drum marked *Mikrofon*.
7. Plug the two-contact plug of the remote telephone handset into the jack on the reel drum marked *Fernhorer*.

NOTE: A microphone and headset may be used instead of the remote telephone handset as long as they are plugged into the correct jacks. The remote telephone handset may be used as the transmitter instead of the microphone and headset.

8. Installation is now complete and the transceiver is ready for operation.

C. Operation.
1. Set up the equipment as indicated in V above.

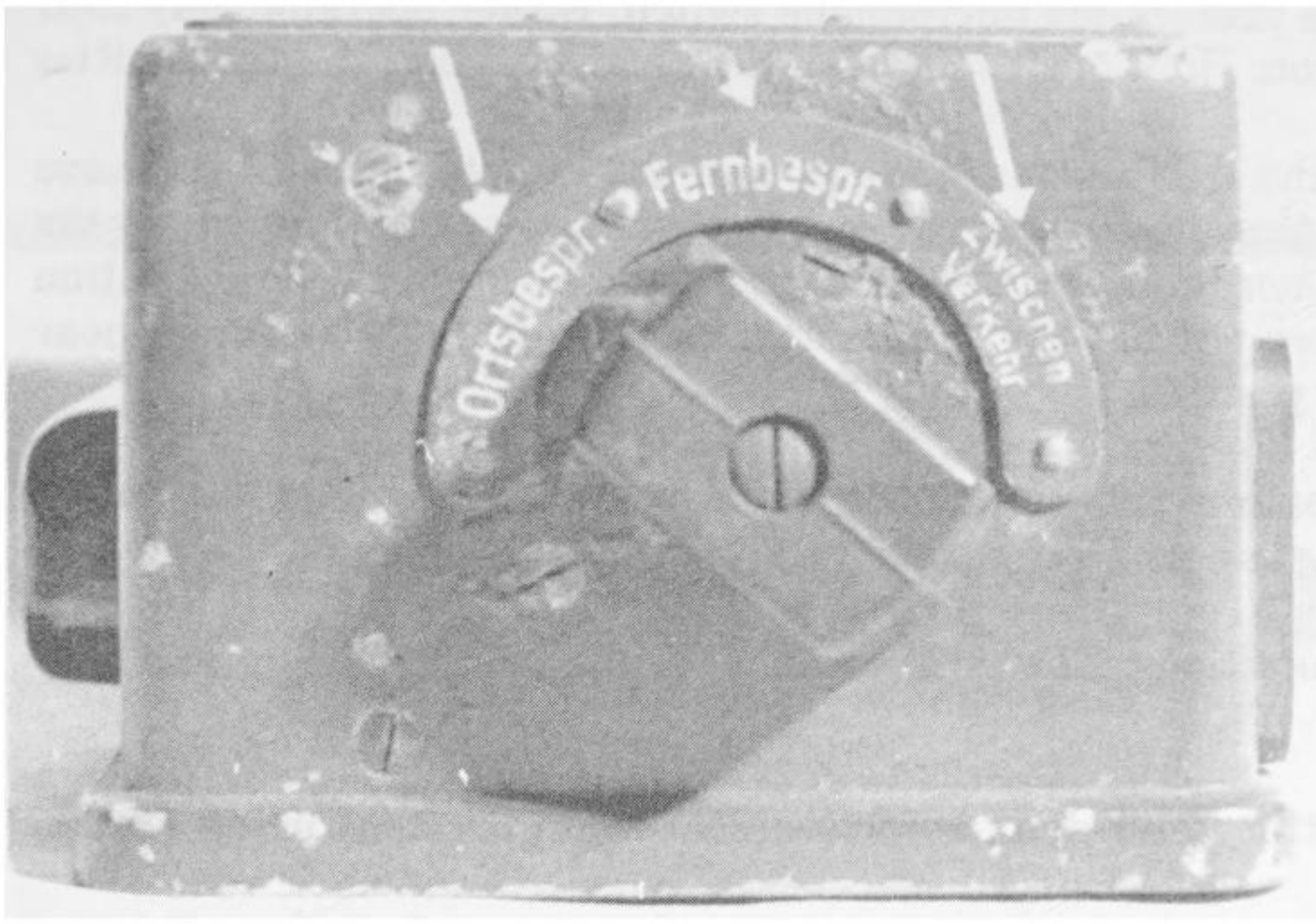


Figure 2.7 *Rear view of the remote control switch box. The Ortsbesper. (local) position allows operation of the transmitter from the transmitter location. The Fernbespr. (remote) position allows operation of the transmitter from the remote position. The Zwischen Verkchr (telephone) position allows the remote and transmitter operator to converse without keying the transmitter.*

2. The control switch box is equipped with a switch that selects any one of the three types of operation (see Figure 2.7).
3. To operate the transmitter from the transmitter location, place the selector switch of the control switch box on *Ortsbesper.* (local) position. In this position, the local transmitter operator puts the transmitter carrier on when he presses his microphone switch. Either the local or remote operator may modulate the transmitter when the carrier is on, and either operator may hear the other operator's conversation. Both operators hear the receiver when the transmitter is off.
4. To operate the transmitter from the remote location, place the selector switch on the control switch box on *Ferbespr.* (remote). In this position, the remote operator puts the

Figure 2.8 *Top view of the remote control switch box. From top to bottom: nameplate, instructions ("When radio set is in the receive or on positions, place the control switch to the telephone position").*

transmitter carrier on when he presses his microphone switch. Either operator may hear the other operator's conversation. Both operators hear the receiver when the transmitter is off.

5. When it is desired to have the transmitter operator and the remote operator converse over the cable without putting the transmitter carrier on, place the selector switch on the control switch box in the *Zwischen Verkehr* (telephone) position (see Figure 2.7). Operation of either microphone switch does not put the transmitter carrier on. Both operators hear the receiver at all times in this position.

VII. MAINTENANCE. Detailed maintenance instructions for this set are not included. An operator should observe the following simple precautions if the set fails to operate:

A. Check all cords, plugs, and connections. The most common faults are in cording and connections.

B. Check the condition of the battery and dynamotor (vehicle configuration) using a voltmeter.

C. If the condition of the tubes is questionable, replace them one at a time, and check the operation after each replacement. Figure 2.9 shows the rear view of the set removed from its case.

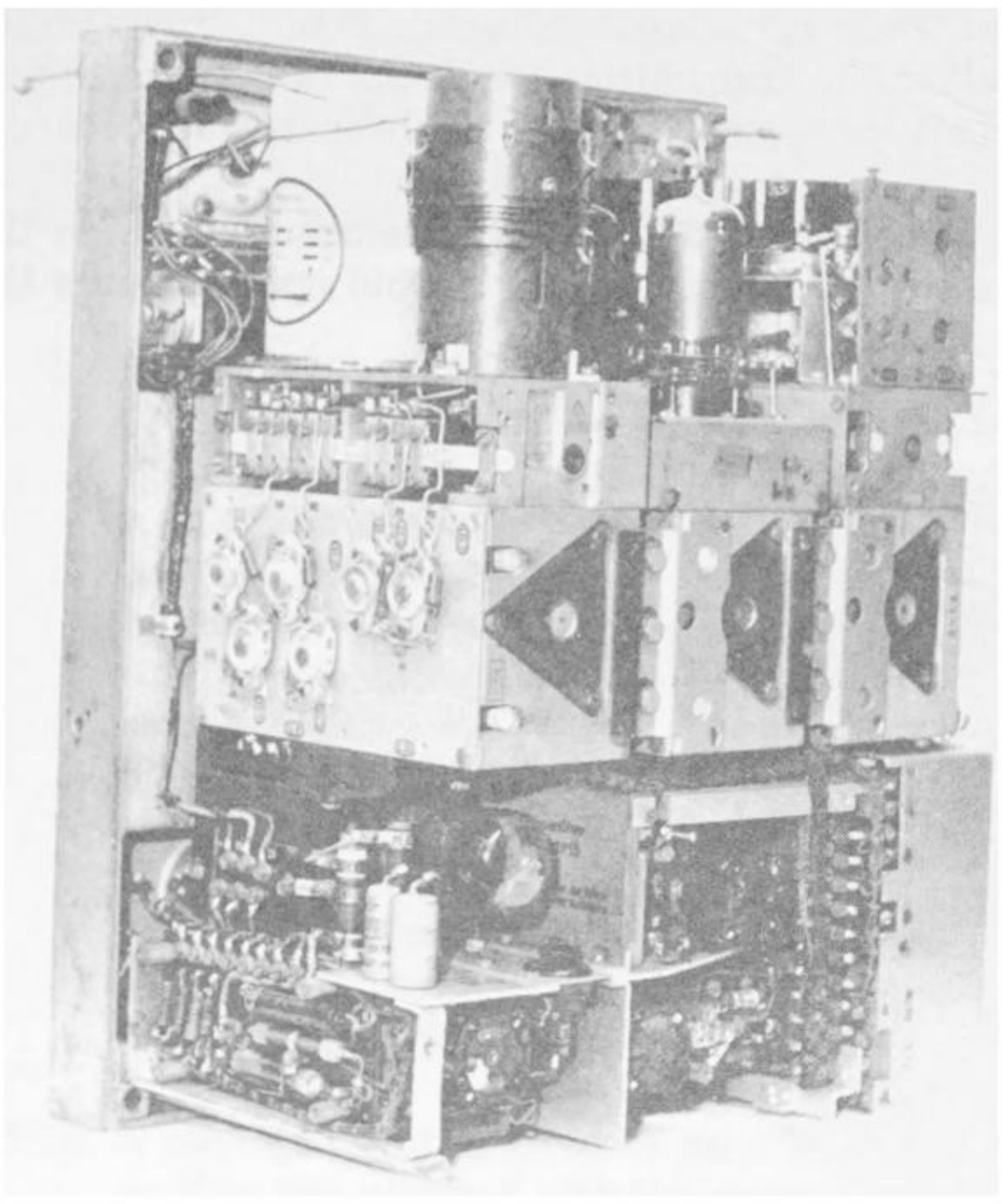


Figure 2.9 *Rear view of the 15 W.S.E. removed from its case.*

CHAPTER 3

The 20-Watt Transmitters

I. DESCRIPTION

A. Transmitter. The German radio transmitters 20 W.S.c (20-watt transmitter c) and 20 W.S.d (20-watt transmitter d) are vehicular radio transmitters capable of transmitting *Telegraphie* and *Telefonie* amplitude-modulated signals. These transmitters are identical except for frequency coverage, and the word "set" hereafter will apply to either. The 20 W.S.c is used with Ukw. E.c (shortwave receiver c), and the 20 W.S.d is used with Ukw. E. dl (shortwave receiver dl). The set is housed in a rainproof and dustproof metal transport case, having a front cover held in place by two clasps. A typical nameplate for the set is shown in Figure 3.1.

Figure 3.1 *Nameplate of the 20 W.S.c. (Credit: U.S. Army)*

B. Dynamotor. The type U 20a3 dynamotor used with this set operates from a 12-volt storage battery. It is housed in a light, cast-metal case that also contains the starting relay and the input and output filter circuits (see Figure 3.6). Figure 3.2 shows a typical nameplate for the U 20a3 dynamotor.

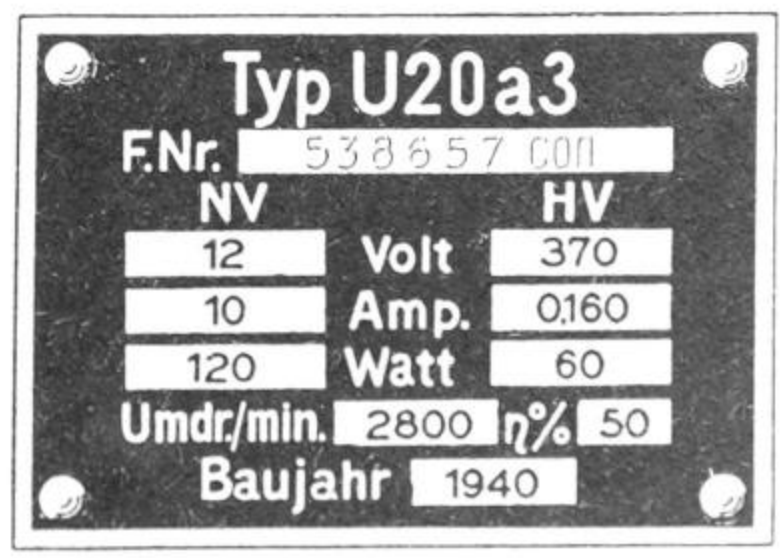


Figure 3.2 *Nameplate of the U20a3 dynamotor. (Credit: U.S. Army)*

II. PERFORMANCE DATA. The table below lists the performance data of the sets.

Frequency range
Transmitter 20 W.S.c: 27,200 to 33,300 kilocycles
Transmitter 20 W.S.d: 42,100 to 47,800 kilocycles

Types of signals
Tone: 800 to 1,000 cycles
Voice: amplitude modulated

Distance range
Tone: approximately 3 miles
Voice: approximately 2 miles

Type of transmitter: master oscillator-power amplifier (MOPA)

Number of tubes: 5
Used for tone: 5
Used for voice: 5

Master oscillator tube: 1 type RL12T15

Double tube: 1 type RL12T15

Power amplifier tubes: 2 type RL12T15 (in push-pull)

Modulator and tone-oscillator tube: 1 type RL12T15

Type of modulation: amplitude

Method of modulation: grid (power amplifier)

Sidetone: present on both voice and tone

Power output: 20 watts

Antenna type: 6.5 ft vertical rod

Power supply: 12-volt storage battery and U 20a3 dynamotor

Power requirements
Filament: approximately 12 volts, 2.75 amperes
Plate: approximately 370 volts, 130 milliamperes

III. INSTALLATION.

A. Location. Mount the set and the dynamotor securely in their mounting racks. If the proper racks are not available, firm supports bonded to the vehicle will have to be constructed.

B. Transmitter.

1. Remove the front cover and set the main switch to the *Aus* position (see Figure 3.4).
2. Connect the antenna through a coaxial cable and suitable polarized plug to the jack marked *Antenne Sender* (antenna receiver). The bottom contact of both antenna jacks is the ground connection; the top contact is the antenna connection. The set is grounded through its mounting in the vehicle.

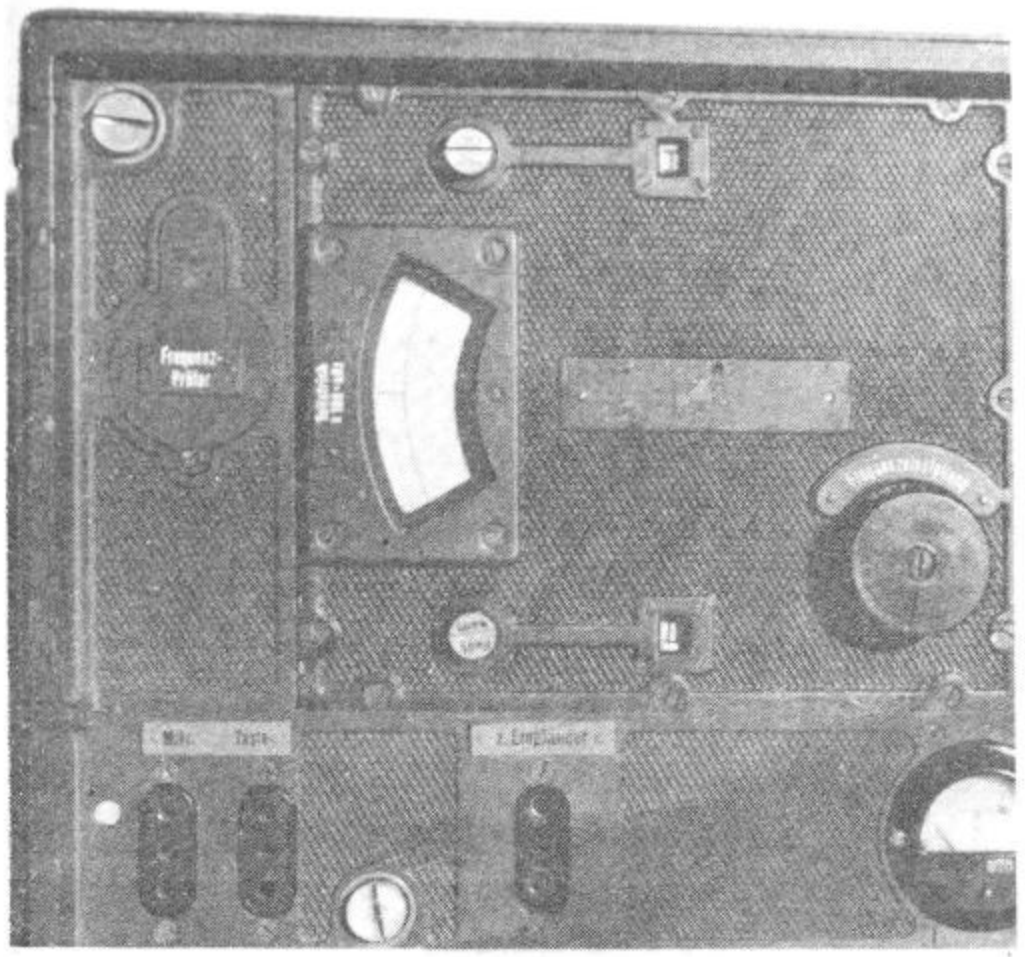


Figure 3.3 *Close-up view of the left side of the set. From left to right: Frequenz-Prüfer (frequency check), Mikr. (microphone) and Taste (Morse key) jacks, dial, preset channel locks and windows (two above and below the window), Frequenzeinstellung (tuning control), voltmeter.*

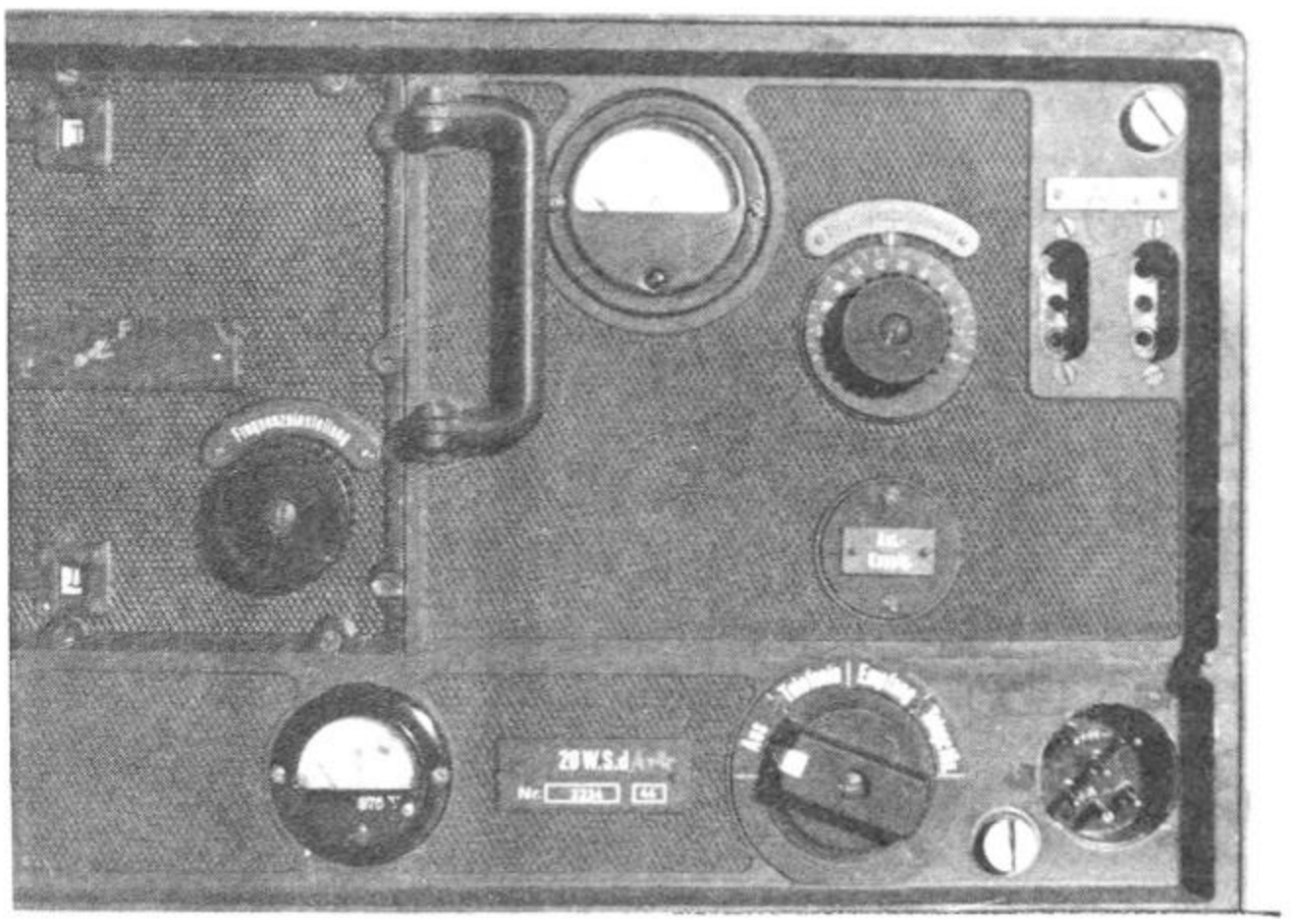


Figure 3.4 *Close-up view of the right side of the set. From left to right: antenna meter, Antennenabstimmung (antenna tuning control), input jacks for antenna, Ant.-Kopplg (antenna coupling), nameplate, main switch, power input receptacle.*

3. Plug a key into the jack marked *Taste* and a microphone into the jack marked *Mikr.* (microphone). Any key or double-button carbon microphone may be used when fitted with the proper plug.

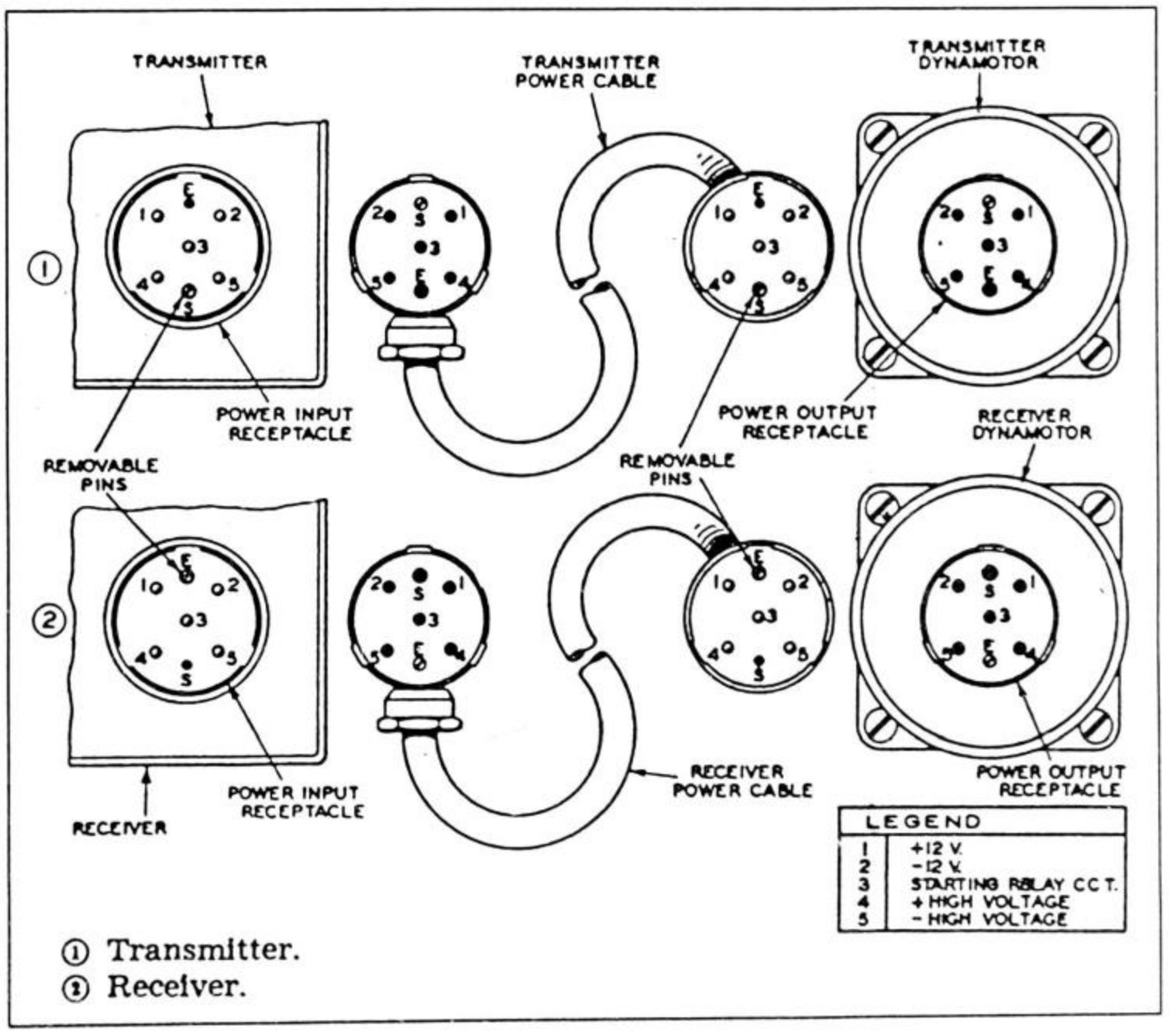


Figure 3.5 *Cabling diagram for the 20 W.S.c, 20 W.S.d, and their associated receivers. (Credit: U.S. Army)*

4. Check the position of the pins and screws in both plugs of the cable as well as in the set and dynamotor receptacles (see Figure 3.5) before connecting the power cable. There should be a setscrew in the hole marked S in the female plug, and a screw pin in the hole marked S in the male plug. The dynamotor receptacle should have a setscrew in the hole marked S, and the set receptacle should have a screw pin in the hole marked S. The

receptacle on the set may not have holes marked; in this case the pin will not be removable. Figure 3.5 also shows the proper pin positions for receiver power-cable plugs and receiver and receiver-dynamotor receptacles.
5. Plug the power cable into the power input receptacle.
6. Make the receiver antenna input connection to the jack marked *Antenne Empf.* using a suitable cable and polarized plug. The transmitting antenna will be connected through to the receiver when the main switch is set to either the *Empfang* or *Aus* position.
7. Plug a cord with a polarized plug into the sidetone jack marked *z. Empf. I* (to receiver 1); plug the other end into the proper jack on the receiver. The jack marked *z. Empf. II* (to receiver 2), which is on the 20 W.S.c only, is for connecting a second receiver, but it does not supply a sidetone.

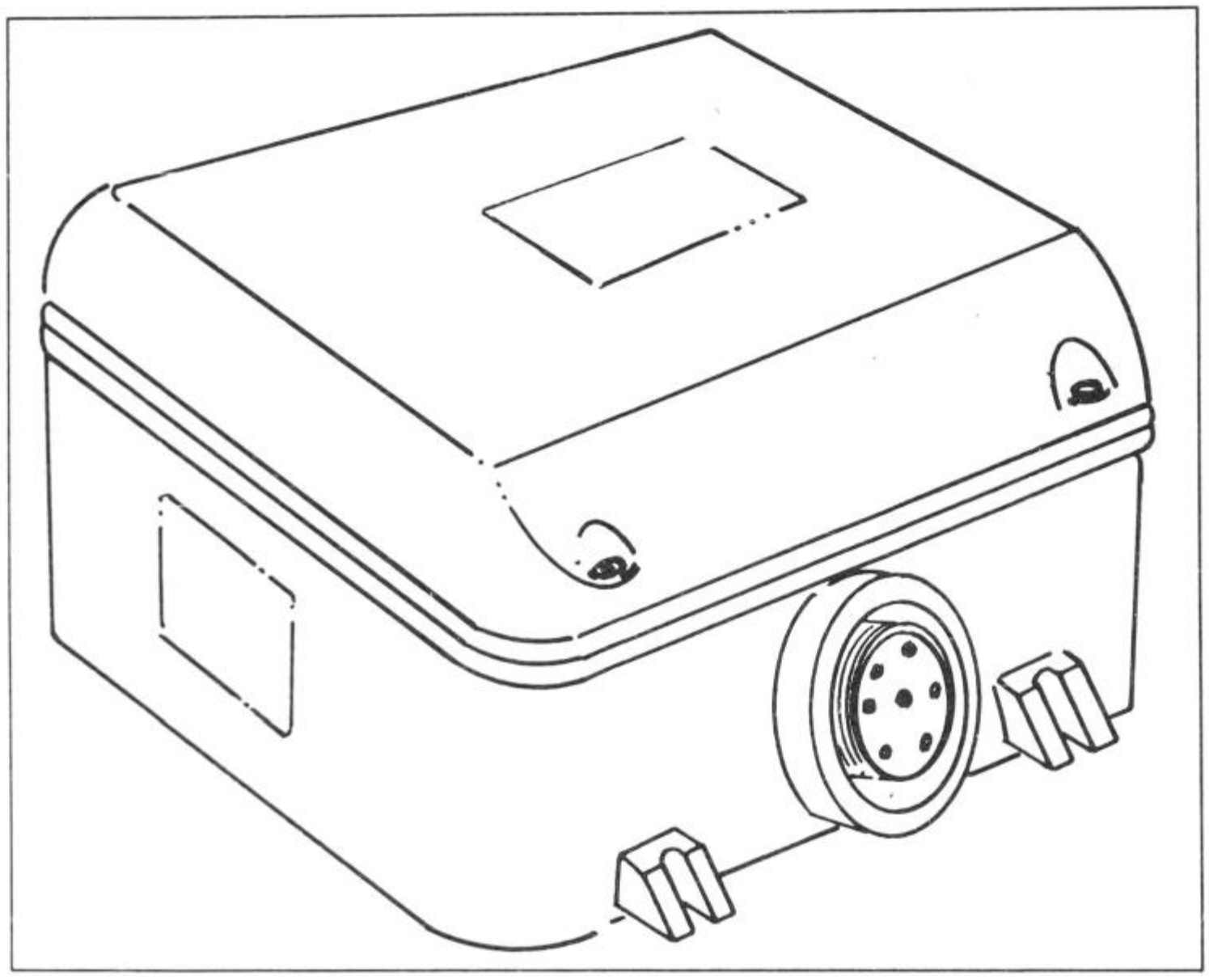


***Figure** 3.6 The U 20a3 dynamotor showing the power receptacle on the front, data plate on the left, and plate on top reading, "DO NOT OPEN IN VEHICLE."*

C. Power Supply. Plug the free end of the power cable into the dynamotor power output receptacle and connect the dynamotor input terminals to a 12-volt storage battery. The negative terminal is grounded to the case. Make sure all connections are tight. Check the fuse in the junction box if it is used. If the junction box is not available, connect a 40-ampere fuse in the positive lead to the storage battery (see Figures 3.6 and 3.7).

D. Antenna. The antenna installation will vary with the type of antenna used. However, do not use an antenna longer than 6.5 feet (approximately 1/4 wavelength).

IV. OPERATION

A. Tuning.
1. Turn the dial to the desired frequency with the knob marked *Frequenzeinstellung*. Frequency in kilocycles = dial reading x 100.
2. Set the main switch to *Telegr. tön.* (tone) and wait five minutes for the tubes to heat. The main switch energizes the dynamotor starting relay when it is set to either the *Telegr. tön* or *Telefonie* position.

CAUTION: *High voltage is present across the contacts of the key.*

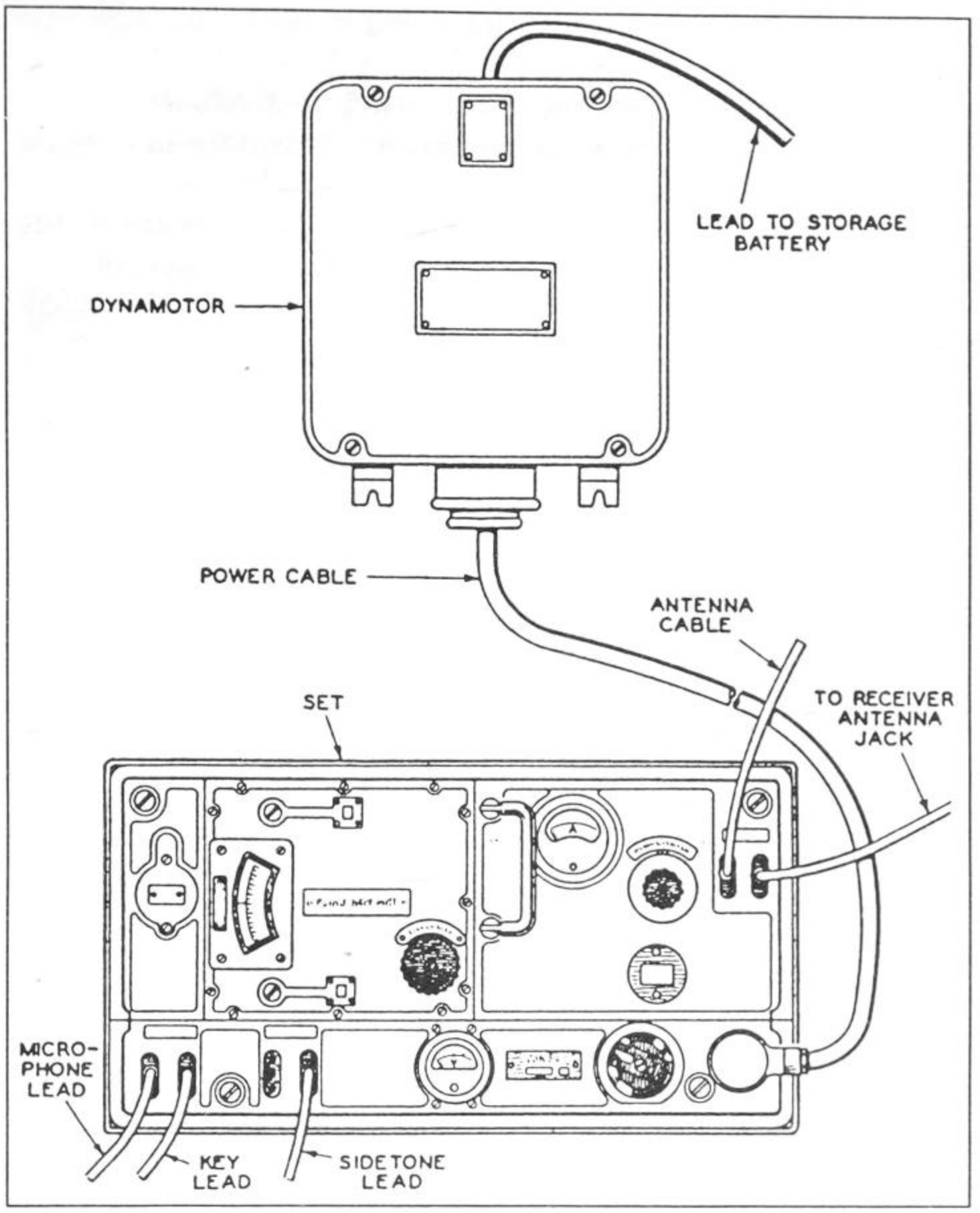


Figure 3.7 *The connection between the 20 W.S.c, U20a3 dynamotor, and various accessories. (Credit: U.S. Army)*

3. Press the key and check the filament and plate voltages on the voltmeter. The filament voltage should be 12 volts (red mark on meter dial), and the plate voltage should be 370 volts (blue mark on meter dial). To read the plate voltage, press the small button on the voltmeter.
4. With the key closed, adjust the *Antennenabstimmung* (antenna tuning) control for maximum reading of the antenna meter. If the meter does not peak, remove the cover marked *Ant.-Kopplg.* (antenna coupling), loosen the locking screw (see Figure 3.8), and turn the coupling control to the right or left until a peak is obtained with the *Antennenabstimmung* control set between 8 and 14. Tighten the locking screw and replace the cover plate. This adjustment need not be made again until the antenna is changed. The set is now properly tuned.

B. Tone Operation.

1. Set the tuning dial to the desired frequency, and set the main switch to *Telegr. tön.*

2. Close the key and adjust the *Antennenabstimmung* control for maximum output. The set is now ready to operate.

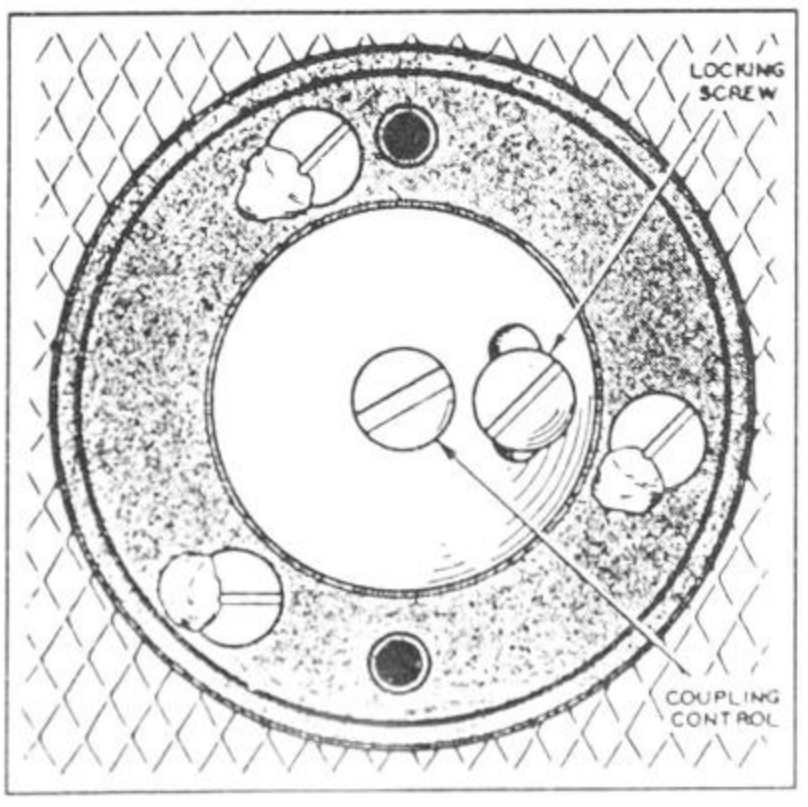


Figure 3.8 *The antenna coupling control for the 20 W.S.c with cover removed. (Credit: U.S. Army)*

C. Voice Operation.

1. Set the tuning dial to the desired frequency and set the main switch to *Telefonie*.
2. Press the microphone switch and adjust the *Antennenabstimmung* control for maximum output.
3. Speak into the microphone while observing the antenna meter. A slight increase in the antenna current indicates modulation is taking place. The set is now ready to operate.

V. PRESET CHANNEL ADJUSTMENTS

A. Turn the knob marked *Frequenzeinstellung* until the desired preset channel number, either I or II, appears in one of the windows (see Figure 3.3). The I appears in the upper preset channel window and the II appears in the lower preset channel window.

B. With a screwdriver or coin, turn the corresponding channel lock marked *Fest Lose* (locked/unlocked) so *Lose* is uppermost.

C. Turn the knob marked *Frequenzeinstellung* until the dial indicates the required frequency.

D. Turn the preset channel in the same manner.

E. Set up the other channel in the same manner.

F. Whenever either preset channel number appears in its window, the set is tuned to the frequency originally chosen. This preset arrangement will also serve as a dial lock, yet it permits easy turning to other frequencies.

VI. CALIBRATION. Because frequency calibration circuits are not built into these sets, a frequency meter such as Frequency Meter Set SCR-211-(&) should be used to calibrate them. Set up and check the frequency meter as directed in its technical manual, and proceed as follows.

NOTE: Symbol (&) indicates any model of Frequency Meter Set SCR-211.

A. Loosen the four red-ringed retaining screws and remove the set from its case.

CAUTION: *This set uses high voltage, which is dangerous to life. Always disconnect the power cable before removing the set from its case.*

B. Make a one- or two-turn loop around the master oscillator tube with a piece of insulated wire, connect the other end to the antenna post of the frequency meter, and place the set back in its case.

C. Turn on the set and the frequency meter and let them operate at least fifteen minutes before making any adjustments.

D. Set the main switch to *Telefonie*, set the tuning dial of the 20 W.S.c to 32,000 kilocycles (46,200 kilocycles for 20 W.S.d), and close the microphone switch.

E. Tune the frequency meter to exactly 3,200 kilocycles for the 20 W.S.c (3,850 kilocycles for 20 W.S.d) and vary the transmitter frequency slowly while listening for a beat note in the headset, which is plugged into the frequency meter.

F. If zero beat is not obtained at exactly 32,000 kilocycles on the 20 W.S.c tuning dial (46,200 kilocycles for 20 W.S.d), set the transmitter dial to this frequency, remove the cover marked *Frequenz-Prüfer* (frequency check), and turn the calibration-adjusting screw until zero beat is obtained (see Figure 3.9). Turn the screw to the left to increase the frequency and to the right to decrease the frequency.

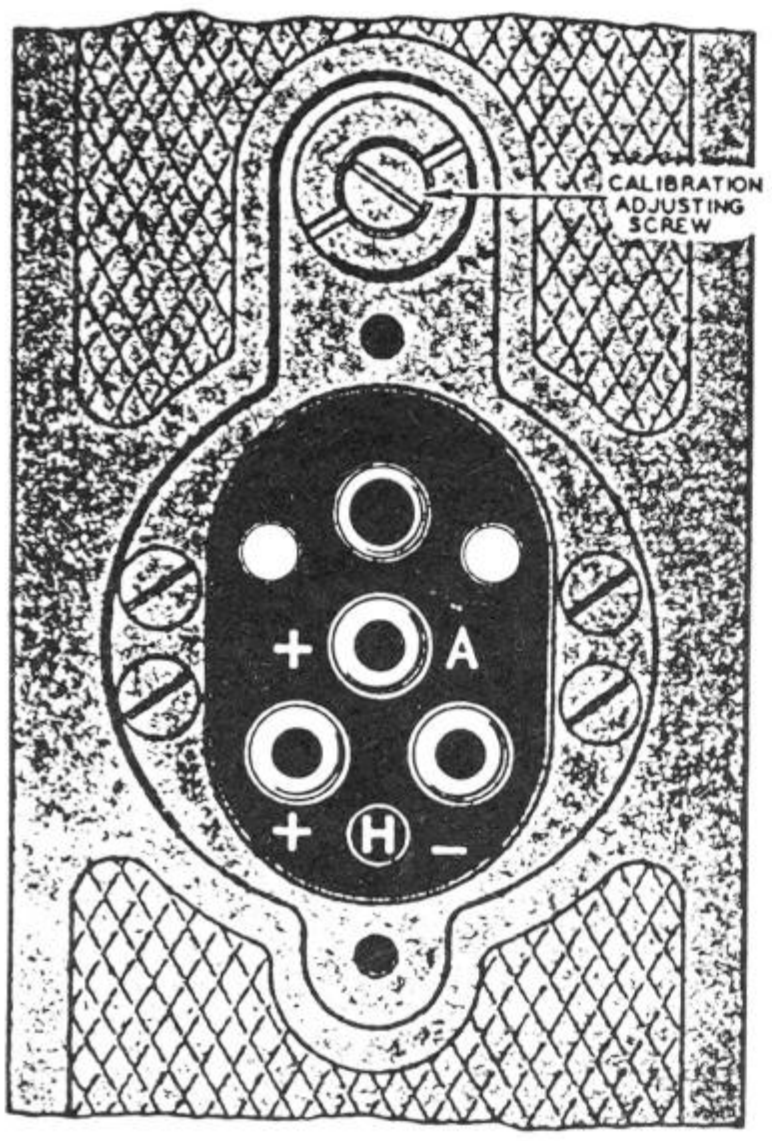


Figure 3.9 *Frequency-check jack and calibration-adjusting screw. (Credit: U.S. Army)*

G. Turn the equipment off, replace the cover plate, and restore the set to its case.

VIII. MAINTENANCE. Detailed maintenance instructions are not given in this chapter. The following suggestions will be helpful in locating the more common faults:

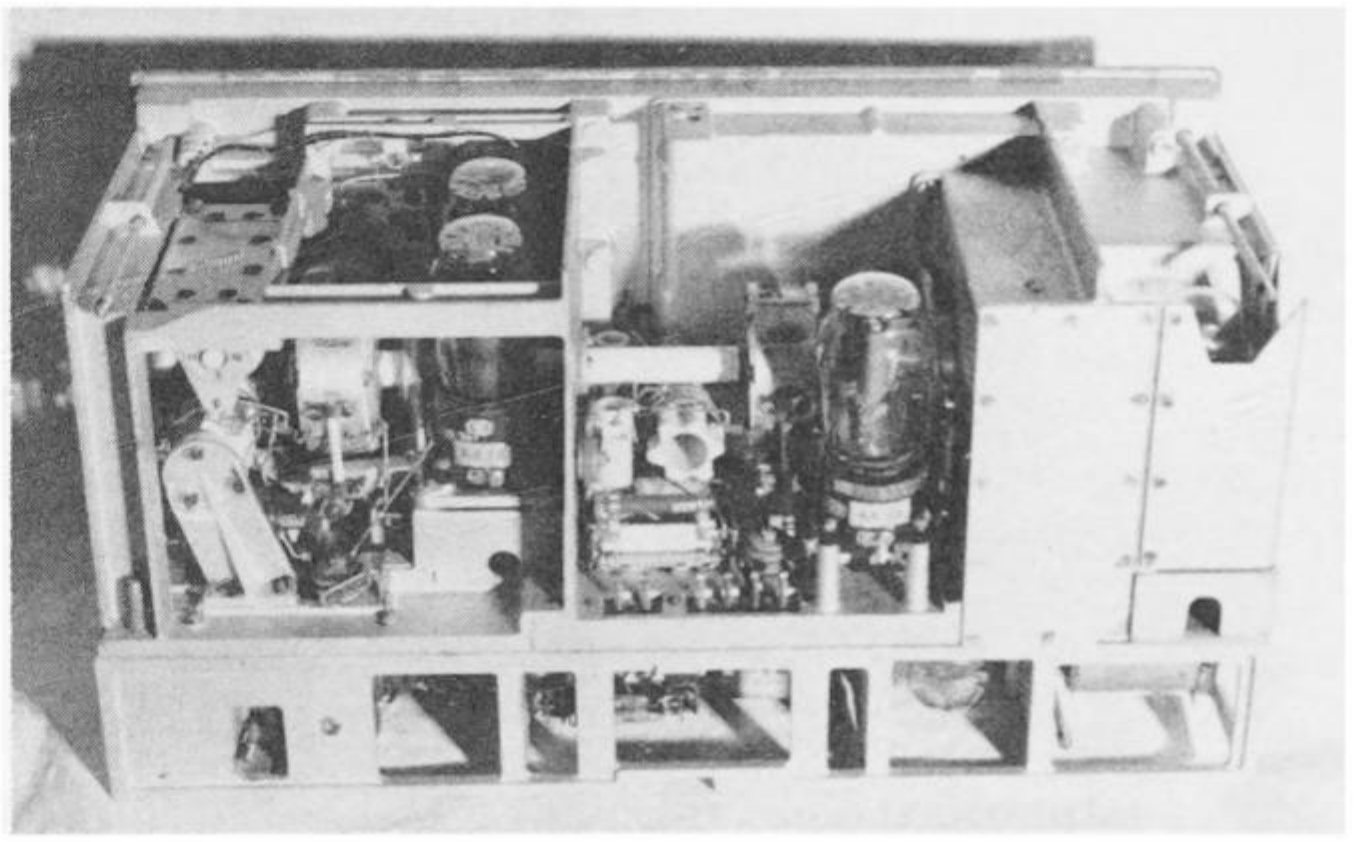


Figure 3.10 *Rear view of the 20 W.S.c removed from its case.*

A. Check all cords and plugs to make sure they are clean and tight.

B. Check the fuse in the dynamotor input circuit.

C. Check the condition of the battery with the voltmeter on the set.

D. Check the tubes by replacing them, one at a time, with tubes known to be good, and check the operation of the set after each replacement. Remove the set from its case when it is necessary to change tubes.

E. The same tube functions as both modulator and tone oscillator. Therefore, if the sidetone is heard in the receiver headset, this tube is functioning properly and need not be checked.

F. If the sidetone can be heard on CW operation but not on voice, check the microphone plug, cord, and switch. If the sidetone can be heard on voice operation but not on CW, check the key, key cord, and plug.

CHAPTER 4

The 30-Watt Transmitter

I. DESCRIPTION.

A. Transmitter. The 30 W.S.a (30-watt transmitter a) is a vehicular radio transmitter capable of transmitting *Telegraphie* (CW), and *Telefonie* (voice) amplitude-modulated signals. The set is generally used in conjunction with Torn. E.b (portable receiver b). It is housed in a rain- and dust-proof sheet metal case, with a front cover held in place by two presser fasteners. A typical nameplate is shown in Figure 4.1.

B. Dynamotor. The German dynamotor type U 30b operates from a 12-volt storage battery and delivers 400 volts at 0.175 ampere. A light cast-metal case houses the dynamotor, the starting relay, and the noise filter. A typical nameplate of the dynamotor is shown in Figure 4.2.

Figure 4.1 *Nameplate of the 30-watt transmitter (30 W.S.a). (Credit: U.S. Army)*

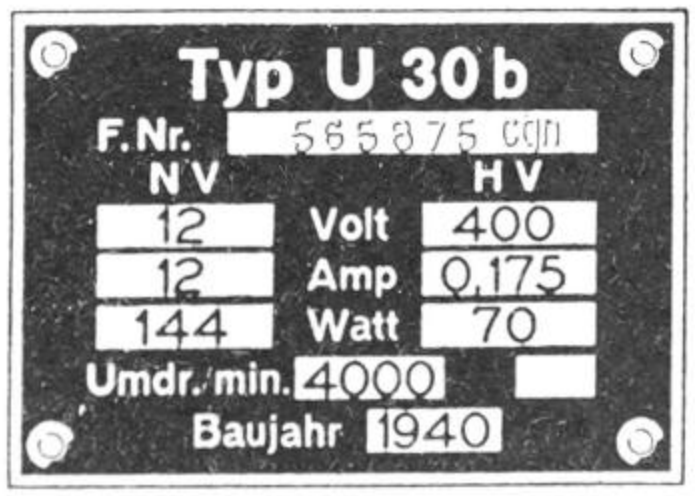


Figure 4.2 *Nameplate of the Type U 30b dynamotor. (Credit: U.S. Army)*

2. PERFORMANCE DATA. The table below lists the performance data and general characteristics of the 30 W.S.a.

Frequency range
- Band I: approximately 1,110 to 1,550 kc
- Band II: approximately 1,530 to 2,150 kc
- Band III: approximately 2,130 to 3,010 kc

Types of signals: CW and voice amplitude modulated

Distance range
- CW (ground): approximately 42 miles
- CW (vehicular): approximately 24 miles
- Voice (ground): approximately 15 miles
- Voice (vehicular): approximately 6 miles

Type of transmitter: master oscillator-power amplifier (MOPA)

Number of tubes: 6
Used for CW: 5
Used for voice: 6

Master oscillator tube: 1 type RL12P35

Power amplifier tube: 2 type RL12P35 (in parallel)

Modulator tubes: 2 type RV12P2000 (in parallel) (used as tone oscillator on CW)

Calibration-oscillator tube: 1 type RL12T15 (used as suppressor grid and grid-bias rectifier on voice)

Method of calibration: crystal-controlled oscillator

Sidetone in set: yes

Type of modulation: amplitude

Method of modulation: suppressor grid of power amplifier

Power output: 30 watts

Antenna type
Ground: 30-foot vertical mast with star flat top
Vehicular: vehicular rod or roof

Power supply: 12-volt storage battery and dynamotor U 30b

Power requirements
Filament: 12 volts, 2.7 amperes
Plate:
CW: 400 volts, 120 milliamperes
Voice: 400 volts, 170 milliamperes

III. CONTROLS. The more important controls on the front panel (see Figure 4.3) and a brief statement of their function are listed below.

A. The *Frequenzeinstellung* (tuning control) operates the dial and ganged tuning capacitors.

B. The *Bereichschalter* (band switch) is used to select any one of three frequency bands.

C. The four-position main switch is labeled as follows:
1. *Nur Empfang* (receive only) and *S.-Aus*. In this position, the transmitter is off and the transmitting antenna is connected through the switch to the *Ant. Empf.* (antenna receiver) binding post.
2. *Tn.* In this position, the transmitter is connected for voice operation and the *Ant. Empf.* binding post is grounded.
3. *S.-Bereit* (transmitter standby) and *Empfang* (receive). In this position, the transmitter plate voltage is off, the filaments are on, and the antenna is connected as in C1 above.

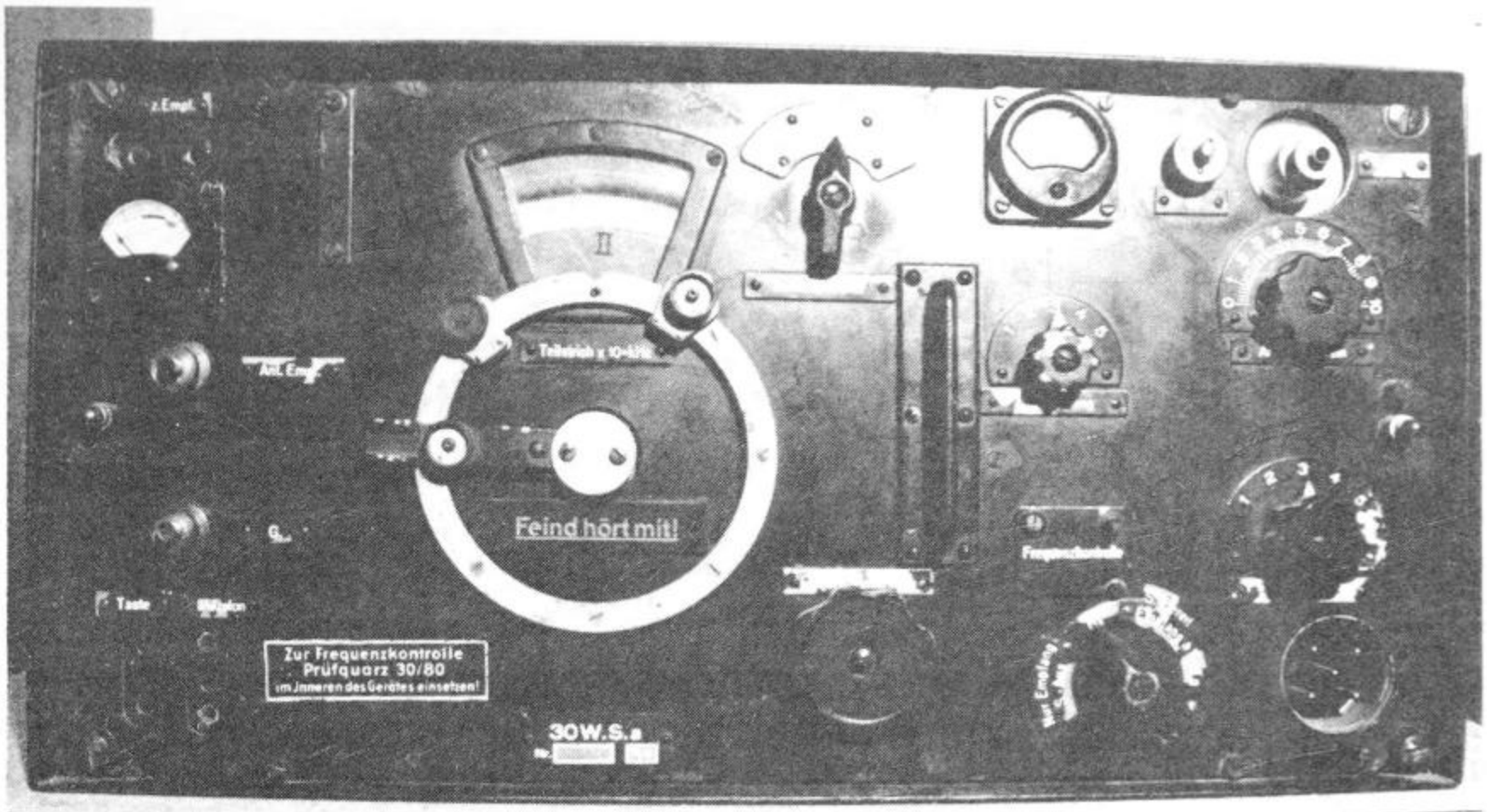
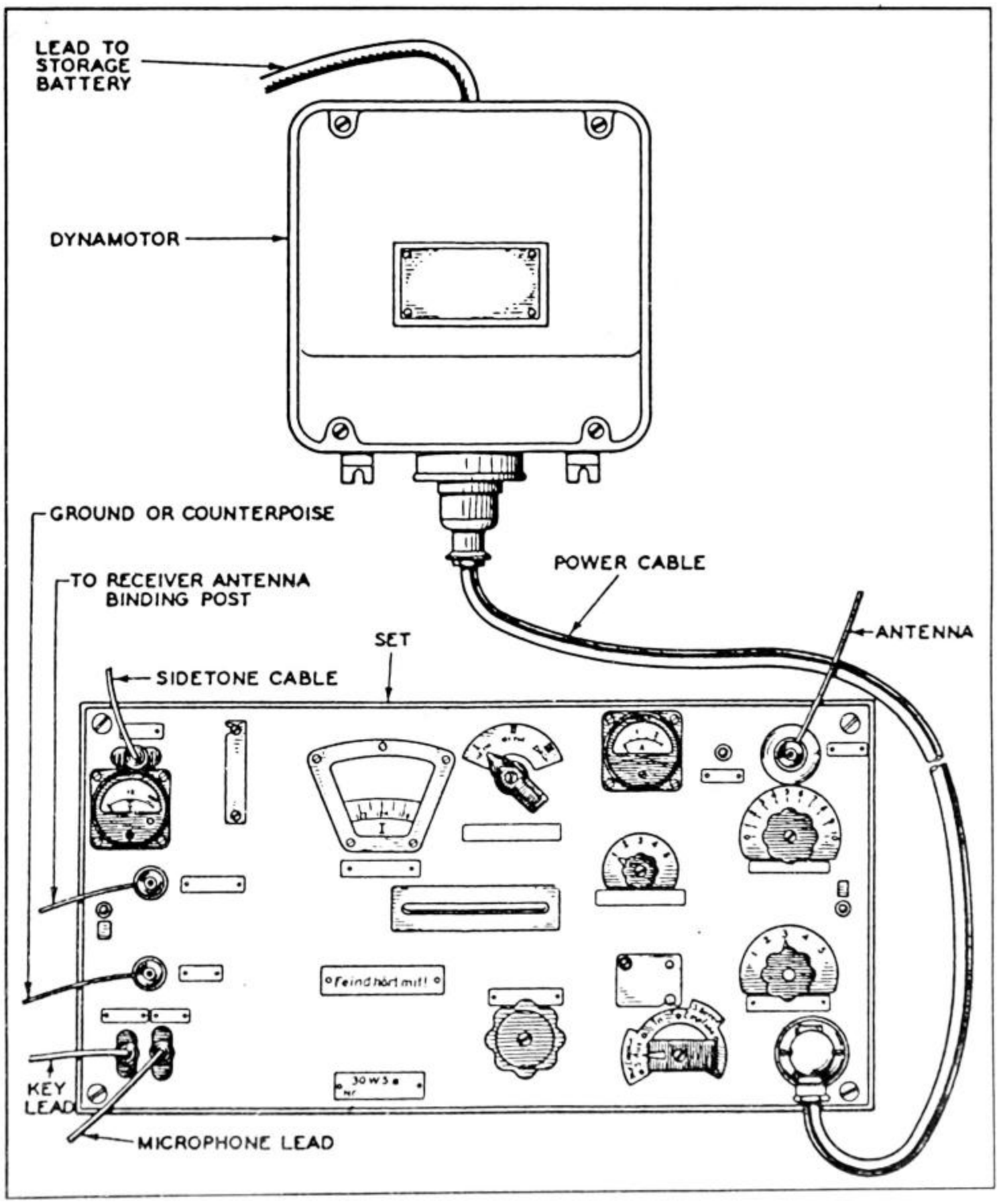


Figure 4.3 *Front view of the 30 W.S.a.*

4. *Tg*. In this position, the transmitter is connected for CW operation, and the *Ant. Empf.* binding post is grounded.

D. The *Frequenzkontrolle* (frequency calibration) jack connects the headset used to check frequency calibration. The jack cover pivots to open and operates a switch that connects the calibrating crystal and opens the screen circuit of the power amplifier tubes.



E. The *Ant. Abst. Gross* (antenna coarse tuning) control is a five-position switch used for selecting antenna series tuning capacitors.

F. The *z. Empf.* (to receiver) sidetone jack may be used for either headset monitoring of all signals or for connecting to a receiver that has connections for monitoring. During CW operation, the modulator tubes are used as an audio oscillator to produce the sidetone.

IV. INSTALLATION

A. Location. Mount the set and the dynamotor securely in their mounting racks. If the proper racks are not available, firm supports will have to be constructed and bonded to the vehicle.

Figure 4.4 *Cording diagram of the 30 W.S.a. (Credit: U.S. Army)*

B. Transmitter.

1. Remove the front cover and set the main switch to *S.-Aus.*
2. Connect the antenna to the *Ant.* (antenna) binding post (see Figure 4.4).
3. Connect a ground or counterpoise to the binding post marked *G.* (connect to chassis in vehicular installation).

NOTE: The pin marked *G.* (counterpoise) on the upper right side of the panel is used to ground the shield of the antenna lead-in and may be disregarded unless the antenna supplied with the set is used.

4. Plug a key into the jack marked *Taste* (key) and a microphone into the jack marked *Mikrofon* (microphone). Any key or single-button carbon microphone fitted with a suitable plug may be used.
5. Connect the sidetone cable from the receiver to the sidetone jack marked *z. Empf.* A headset may be plugged into this jack if the receiver used does not have a sidetone connection.

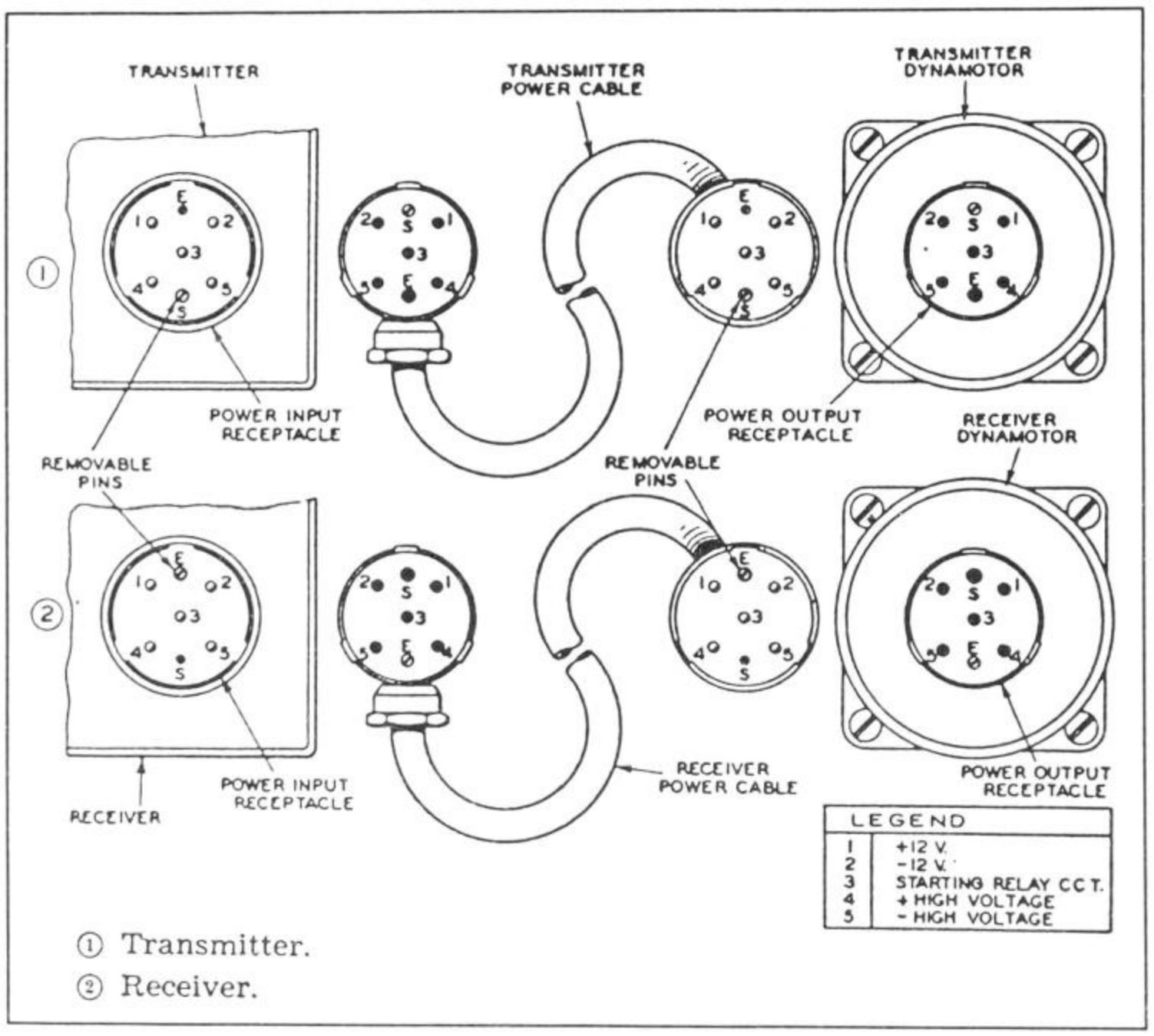


Figure 4.5 *Cording diagram of the 30 W.S.a with the Type U 30b dynamotor. (Credit: U.S. Army)*

6. Connect the lead from the receiver antenna binding post to the binding post marked *Ant. Empf.*
7. Before connecting the power cable, check the position of the pins and screws in both plugs of the cable as well as in the set and dynamotor receptacles (see Figure 4.5). There should be a setscrew in the hole marked S in the female plug, and a screw pin in the hole marked S in the male plug. The dynamotor receptacle should have a screw pin in the hole marked S. Figure 4.5 shows the proper pin positions for receiver power-cable plugs and receiver and receiver-dynamotor receptacles.
8. Plug the power cable into the power input receptacle.

C. Power Supply. Plug the free end of the power cable into the dynamotor power output receptacle and connect the input terminals to a 12-volt storage battery. Make sure all connections are tight.

D. Antenna. Because antenna installation varies with the type of antenna used, no instructions will be given.

V. OPERATION

A. Tuning.

1. After the set has been installed as directed in IV, turn the control marked *Bereichschalter* to the range desired, and turn the dial to the frequency wanted with the knob marked *Frequenzeinstellung*. Frequency in kilocycles = dial reading x 10.
2. Set the main switch to *Tg*. and wait one minute for the tubes to heat.

NOTE: Close the key while making the following adjustments.

3. Check the filament and plate voltage reading on the voltmeter.
   a) The filament voltage should be 12 volts as indicated by the red mark on the meter dial.
   b) Press the blue button; the plate voltage should be 400 volts as indicated by the blue mark on the meter dial.
4. Set the *Ant. Kopplung* (antenna coupling) control to position 3 and the *Ant. Abst. Fein* (antenna fine tuning) control to its central position.
5. Adjust the *Ant. Abst. Gross* control for the highest reading on the antenna meter A and then adjust the *Ant. Abst. Fein* control for peak meter reading. If the meter does not peak, and a maximum reading is obtained when the *Ant. Abst. Fein* control is in the extreme right (or left) position, set the *Ant. Abst. Gross* control one point to the right (or left). In either case, make the final adjustment with the *Ant. Abst. Fein* control.
6. Try to increase the output by adjusting the *Ant. Kopplung* control and then adjust the *Ant. Abst. Fein* control. Once the *Ant. Kopplung* control is adjusted for maximum output, it will require no further adjustment when the frequency is changed provided the same antenna is used. The set is now ready to operate.

B. CW Operation.

1. For CW operation, set the *Bereichschalter* control and the tuning dial to the desired frequency.
2. Set the main switch to *Tg*. and wait one minute for the tubes to heat.
3. Press the key and adjust the *Ant. Abst. Fein* control for maximum output. The set is now ready to operate.

C. Voice Operation.

1. For voice operation, set the *Bereichschalter* control and the tuning dial to the desired frequency.
2. Set the main switch to *Tn*. and wait one minute for the tubes to heat.
3. Press the microphone switch and adjust the *Ant. Abst. Fein* control for maximum output.
4. Speak into the microphone while observing the antenna meter. A slight upward swing indicates modulation is taking place. The set is now ready to operate.

VI. CALIBRATION

A. Frequency Check.

1. Release the cover plate labeled *Frequenzkontrolle*, swivel it 90 degrees to the left, and plug a headset into the jack.
2. Set the main switch to the *Tn*. position and allow the tubes to heat for at least five minutes.

NOTE: No antenna current will be present when a frequency check is made since the power tubes are made inoperative by a switch actuated by the cover plate.

3. Set the *Bereichschalter* control on position I and set the dial to the blue dot at 116.4 (1,164 kc). Blue calibration marks are provided on the dial scales according to the points in the following table.

Band I: 1,164 kc (dot) and 1,552 kc (line)
Band II: 1,552 kc (dot) and 1,940 (line)
Band III: 2,328 kc (dot) and 2,716 kc (line)

4. Press the microphone switch and listen in the headset for a beat note. If none is heard, rock the dial a few divisions either side of the blue calibration mark. Repeat for all check points. The set should be calibrated if zero beat is not obtained at each point.

B. Calibration Reset.

1. Set the *Bereichschalter* control on position I and set the dial to the blue line at 155.2 (1,552 kc).
2. Uncover the calibration adjustment screws, press the microphone switch, and adjust screw I for zero beat.
3. Turn the dial to 116.4 (1,164 kc) and check that zero beat occurs within the blue dot.
4. Repeat for bands II and III. If zero beat does not occur within the blue dot on each band, do not make any further adjustment of the calibration adjustment screws, as the set cannot be properly calibrated. Send it back to a signal depot.
5. Set the main switch to *S.-Aus*, remove the headset, and replace the two cover plates.

VII. MAINTENANCE. Detailed maintenance instructions for this set are not included. Observe the following simple precautions if the set fails to work:

A. Check the condition of the battery and dynamotor with the voltmeter on the panel.

B. Check all cords, plugs, and connections. The most common faults are found in cording and connections.

C. If no plate voltage is indicated on the voltmeter, remove the set from its case by loosening the red-circled retaining screws in each corner of the panel. Check the fuse located just behind the *Ant. Abst. Gross* control. *Ersatzsicherungen* (spare fuses) will be found on the other end of the chassis.

CAUTION: *This set uses high voltages, which are dangerous to life. Exercise extreme care when making measurements inside the set with the power on.*

D. Replace the tubes one at a time if their condition is questionable and check the operation after each replacement.

E. If the set works on *Tg.* but not on *Tn.*, the calibration oscillator tube type RL12T15, as well as the modulator tubes type RV12P2000, may be bad. If the set works on *Tn.* but not on *Tg.*, the trouble will likely be in the key or its cord or plug.

F. The following table lists the voltages that may be measured with a test voltmeter at the test panel on the back of the chassis (see Figures 4.6 and 4.7). All voltages are approximate and are measured between any terminal marked "a" (chassis) and the other terminals.

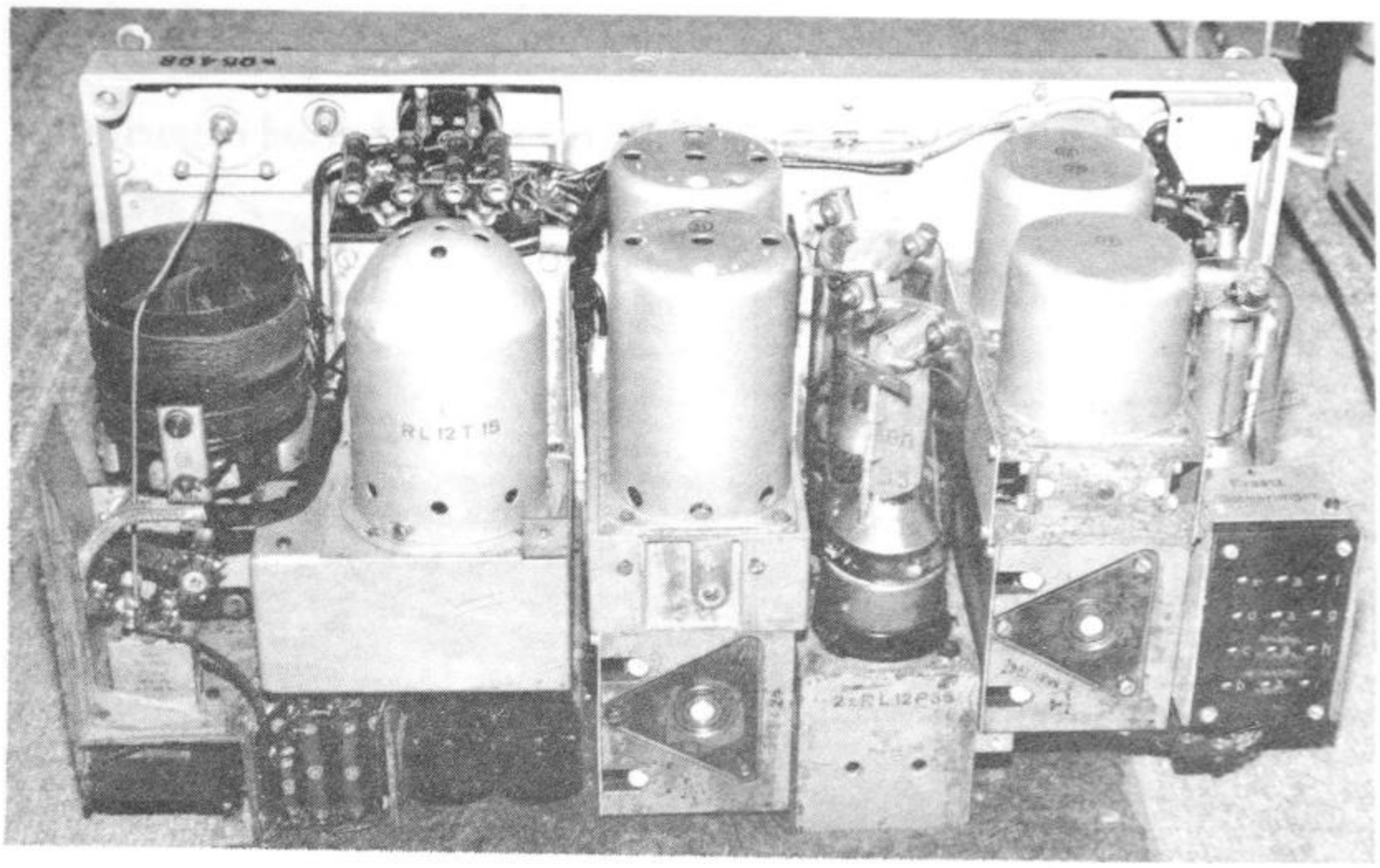


Figure 4.6 *Rear view of the 30 W.S.a removed form the case. Note the test panel at lower right.*

Terminal	CW		Voice	
	Key open	Key closed	Microphone switch open	Microphone switch closed
a	0	0	0	0
b	+12	+12	+12	+12
c	0	0	0	-175
d	+350	+200	0	+180
e	+350	+200	0	+180
f	+400	+400	0	+400
g	+400	+190	0	+400
h	+130	+75	0	+75
i	+400	+400	0	+400

G. If the storage battery, dynamotor, key, microphone switch, and power cable have been checked and are known to be good, and the set fails to operate, make the voltage measurements tabulated in F above using the values in the table above as a guide.

1. No voltage at terminal "b" indicates a defective main switch or faulty wiring in the set.
2. Low or zero voltage at terminal "c" indicates:
   a) Defective main switch, frequency check switch, or relay.
   b) Open fuse, coil, or resistors.
   c) Shorted capacitors or bad calibration oscillator tube.
3. Low or zero voltage at terminals "d" and "e" indicates a defective calibration jack switch or relay, an open fuse, open resistors, or shorted capacitors.
   a) Tube 10 is defective if a high voltage reading is obtained at terminal "d."
   b) Tube 11 is defective if a high voltage reading is obtained at terminal "e."

NOTE: The symbols 10 and 11 refer to the tubes and appear on the chassis near the tube sockets.

   c) The set will operate at reduced power with a defective power amplifier tube provided the tube is not shorted.
4. Low or zero voltage at terminal "f" indicates an open fuse or open choke, shorted capacitors, or a defective relay.

open fuse.

6. Low or zero voltage at terminals "h" or "i" indicates a defective relay, shorted capacitors, or an open fuse, choke, or resistor.

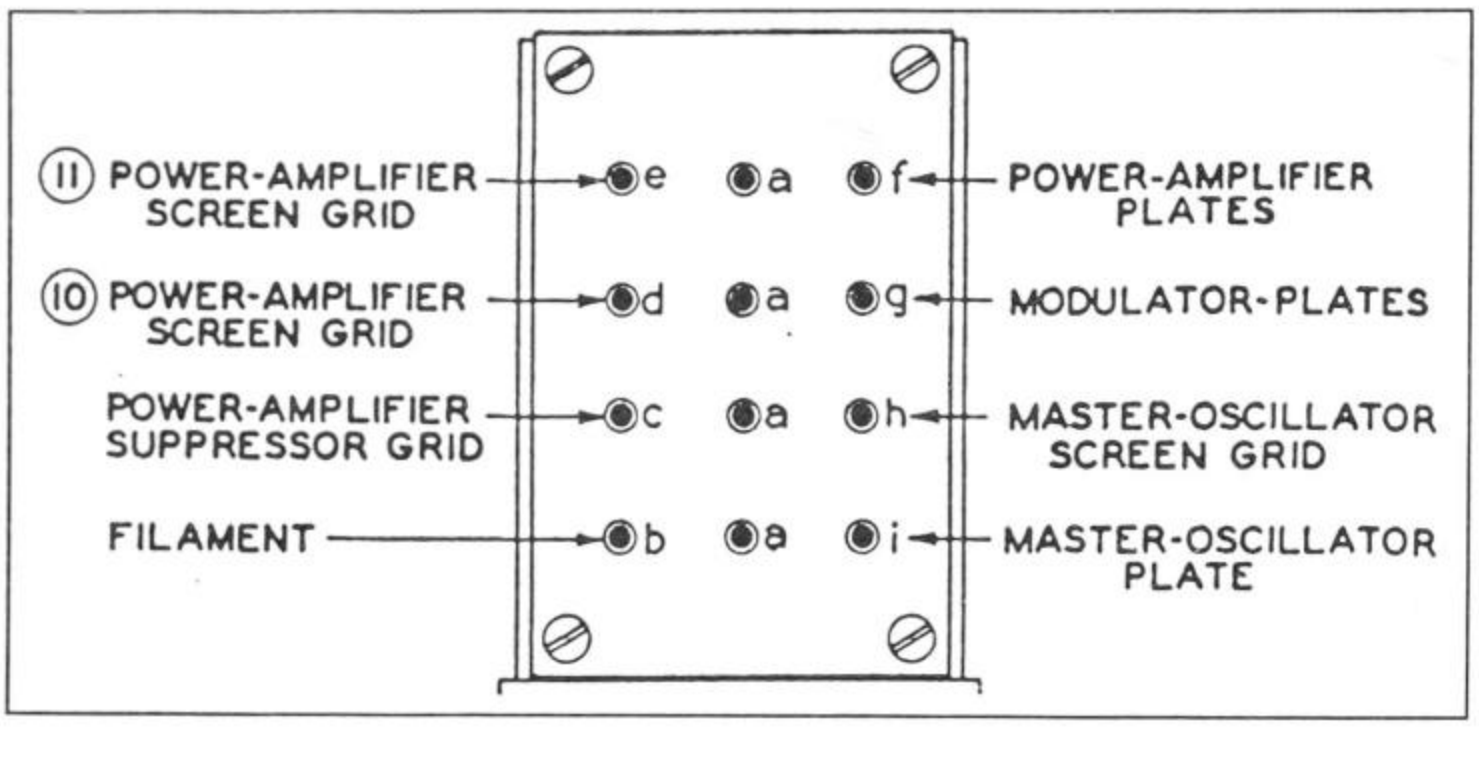


***Figure 4.7** Test panel of the 30 W.S.a transmitter.*

CHAPTER 5

The 80-Watt Transmitter

I. DESCRIPTION

A. Transmitter. The 80-watt transmitter, or 80 W.S.a, is a portable transmitter capable of transmitting *Telegraphie* or *Telefonie* amplitude-modulated signals. The set is generally used with *Torn. E.b* (portable receiver b) and with other amplitude-modulated sets within the same frequency and distance range. It is housed in a rain- and dust-proof sheet metal case with the front cover held in place by two clasps. A typical nameplate for this set is shown in Figure 5.1.

Figure 5.1 *Nameplate of the 80-watt transmitter. (Credit: U.S. Army)*

B. Dynamotor. Dynamotor *Typ U 80a* (type 80a) used with the set operates from a 12-volt storage battery and supplies plate and grid bias voltages. It is housed in a cast-metal case, which also contains the starting relay and nose filters. The power input and power output receptacles are on the same side of the case. A typical nameplate for this dynamotor is shown in Figure 5.2.

II. PERFORMANCE DATA. The following table lists the performance data of the set.

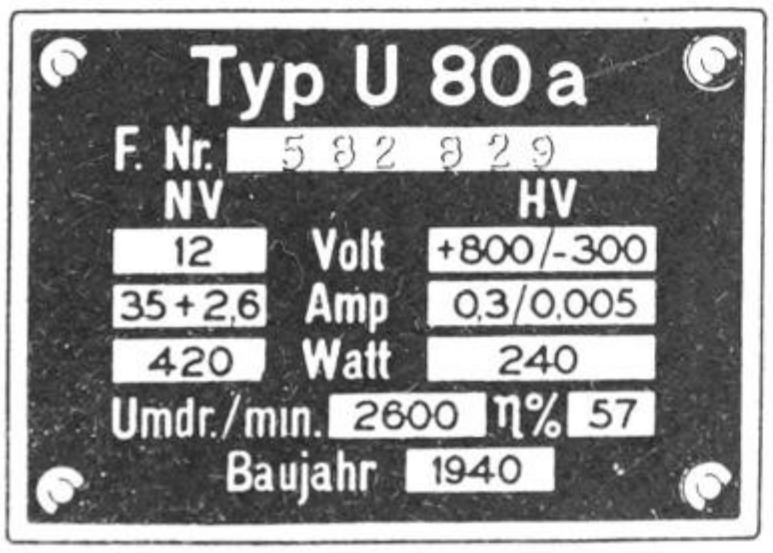


Figure 5.2 *Nameplate of the Type U 80a dynamotor. (Credit: U.S. Army)*

Frequency range

Band I: approximately 1,100 to 1,550 kilocycles
Band II: approximately 1,530 to 2,150 kilocycles
Band III: approximately 2,130 to 3,010 kilocycles

Type of signals: CW and voice

Distance range

CW (ground station): approximately 75 miles
CW (vehicular): approximately 35 miles
Voice (ground): approximately 30 miles
Voice (vehicular): approximately 15 miles

Type of transmitter: master oscillator-power amplifier (MOPA)

Number of tubes: 6
Used on CW: 5
Used on voice: 6
Master oscillator tube: 1 type RL12P35
Power amplifier tubes: 2 type RL12P35 (in parallel)
Modulator tubes: 2 type RV12P2000 (in parallel)
Calibration oscillator tube: 1 type RV12P2000

Method of calibration: crystal-controlled oscillator

Type of modulation: amplitude

Method of modulation: suppressor grid of power amplifier

Power output: high, 80 watts
low, 10 watts

Antenna type
Ground: 30-foot vertical mast or long wire
Vehicular: 15-foot vehicular rod or roof type

Power supply: 12-volt storage battery and dynamotor Type U 80a

Power requirements
Filament: approximately 12 volts 2.3 amps
Plate high power: approximately 800 volts 800 millamperes
Plate low power: approximately 800 volts 200 milliamperes
Grid: approximately 300 volts 5 milliamperes

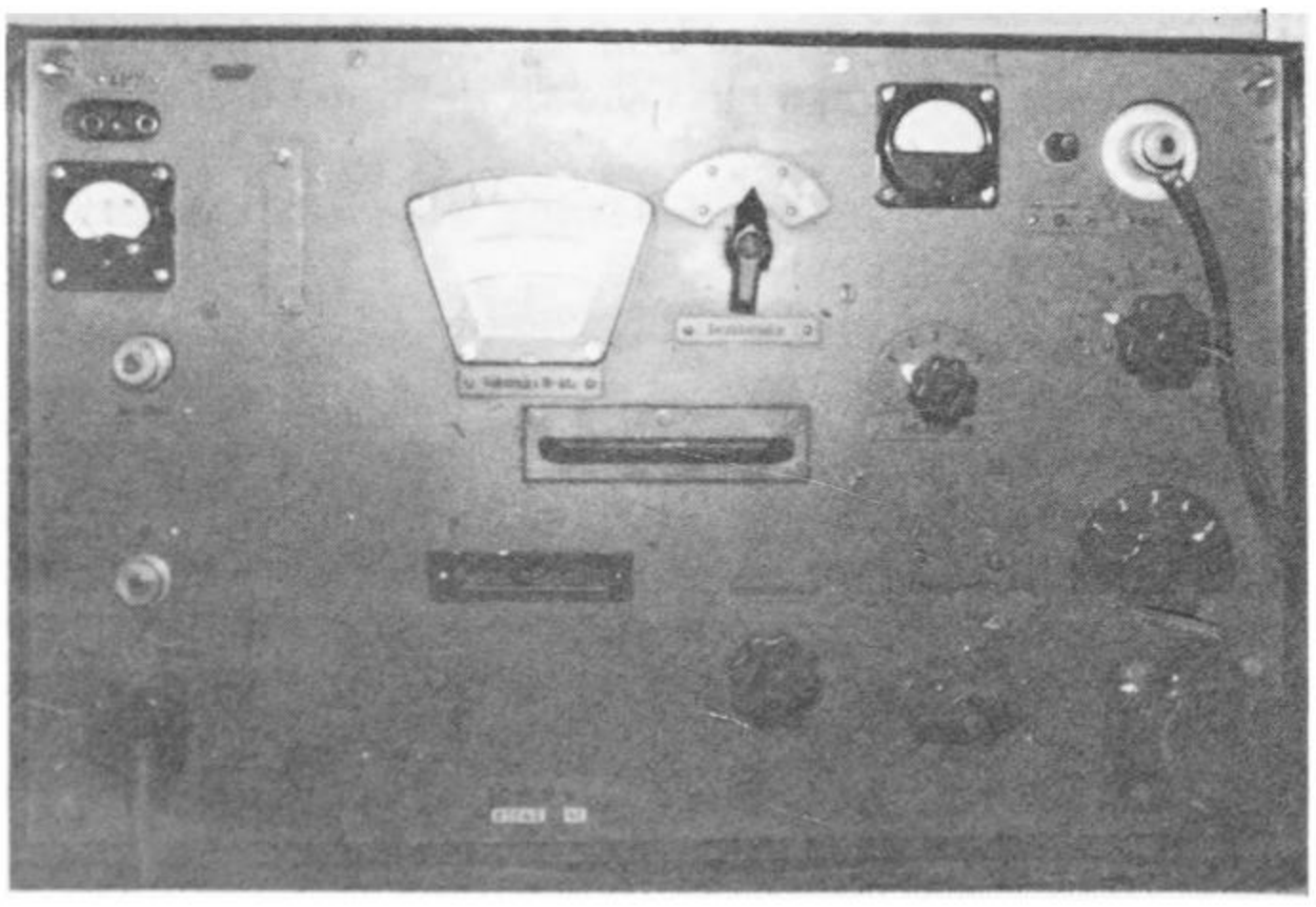


Figure 5.3 *Front view of the 80 W.S.a.*

III. CONTROLS. A brief description of the more important controls (see Figure 5.3) and their functions is as follows:

A. The *Frequenzeinstellung* operates the dial and ganged tuning capacitors.

B. The *Bereichschalter* is used to select any one of three frequency bands.

C. The four-position main switch is labelled as follows:
1. *Nur Empfang* and *S.-Aus*. In this position the transmitter is off and the transmitting antenna is connected to the *Ant. Empf.* binding post.
2. *Tn*. In this position the transmitter is connected for voice operation and the *Ant. Empf.* binding post is grounded.
3. *S.-Bereit* and *Empfang*. In this position the plate voltage of the transmitter is off. The filaments are on and the antenna is connected as in C1 above.
4. *Tg*. In this position the transmitter is connected for CW operation and the *Ant. Empf.* binding post is grounded.

D. The *Frequenzkontrolle* jack is for the headset used to check frequency calibration. The jack cover pivots to open and operates a switch to turn on the crystal-controlled oscillator.

E. The *Ant. Abst. Gross* control is a five-position switch used for selecting antenna series tuning capacitors.

F. The *Ant. Kopplung* control is a five-position switch used for selecting antenna coupling capacitors.

G. The *Ant. Abst. Fein* control is for antenna series tuning.

H. The *z. Empf.* sidetone jack may be used for either headset monitoring of all signals or for connecting to a receiver that has connections for monitoring. On CW operation, the modulator tubes are used as an audio oscillator to produce the sidetone.

I. The 80W 10W (80 watts 10 watts) high-low power switch is used to change the power amplifier screen grid voltage.

IV. INSTALLATION

A. Location. Mount the set and the dynamotor securely at a convenient place in the vehicle. If the proper racks are not available, firm supports will have to be constructed and bonded to the vehicle. Figure 5.4 shows the transmitter and the dynamotor set up for operation.

B. Transmitter. Remove the front cover and set the main switch to the position marked *S.-Aus*. Connect the antenna lead-in to the *Ant.* binding post. Connect a counterpoise (vehicle chassis if mobile installation) or ground to the binding post marked *G*. Plug a key into the jack marked *Taste* and a microphone into the jack marked *Mikrofon*. Any key or single-button carbon microphone may be used if fitted with the proper plug. Plug the power cable into the power-input receptacle.

NOTE: The pin marked *G*. on the upper right side of the panel is used to ground the shield of the antenna lead-in supplied with the set and may be disregarded unless this antenna is used.

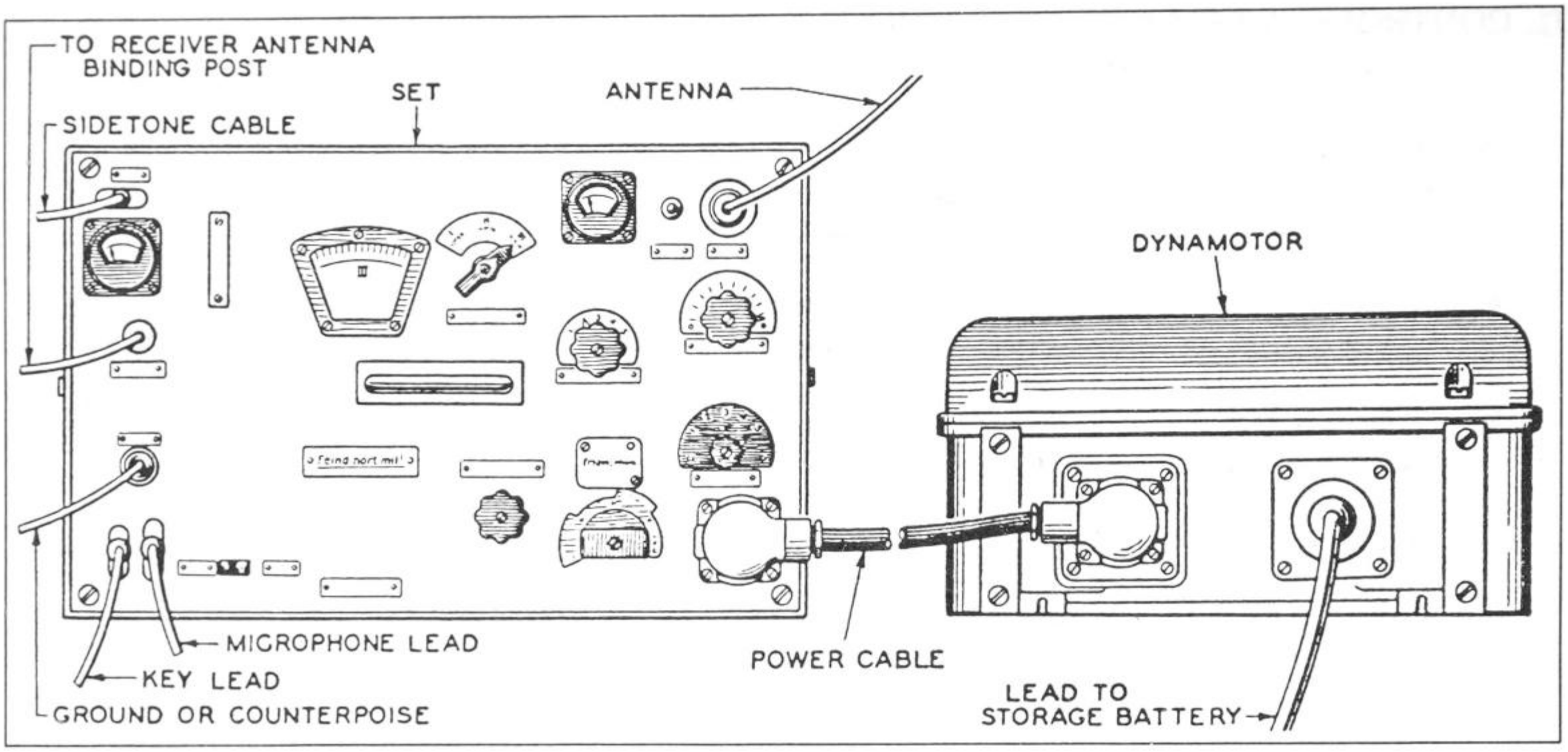


Figure 5.4 *The 80 W.S.a set up with the Type U80a dynamotor. (Credit: U.S. Army)*

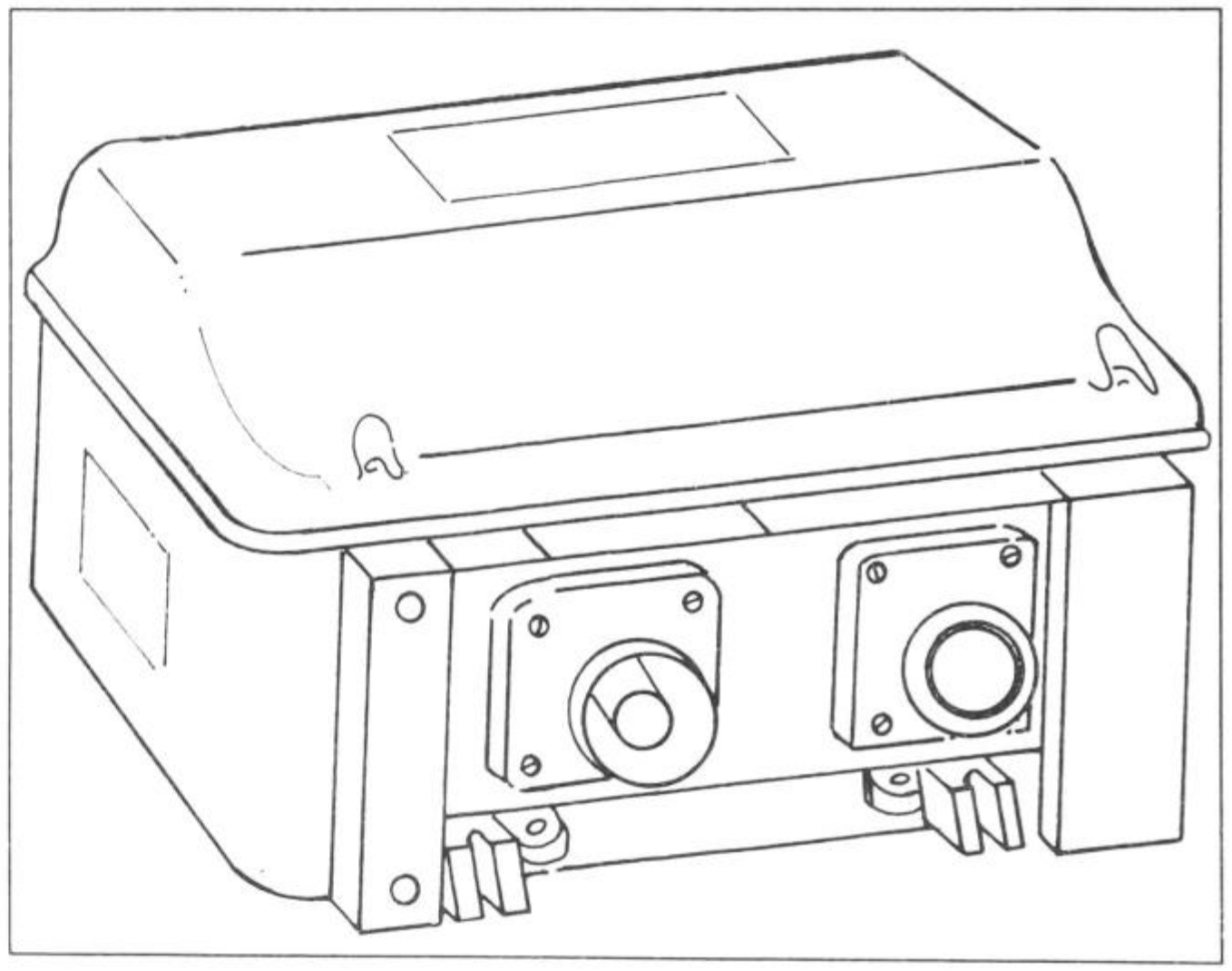


Figure 5.5 *The U 80a dynamotor.*

C. Power Supply. Plug the free end of the lower cable into the dynamotor power-output receptacle and connect the input terminals to a 12-volt storage battery. Since the power-input receptacle is of a concentric type (see Figure 5.5), some means will have to be devised to make the connection when the proper plug is not available. The easiest way is to remove the dynamotor cover and make the connection to the large screw just above the input receptacle. The negative terminal of the battery should connect to the dynamotor case. Figure 5.6 shows the lower cable connections for the set.

D. Antenna.

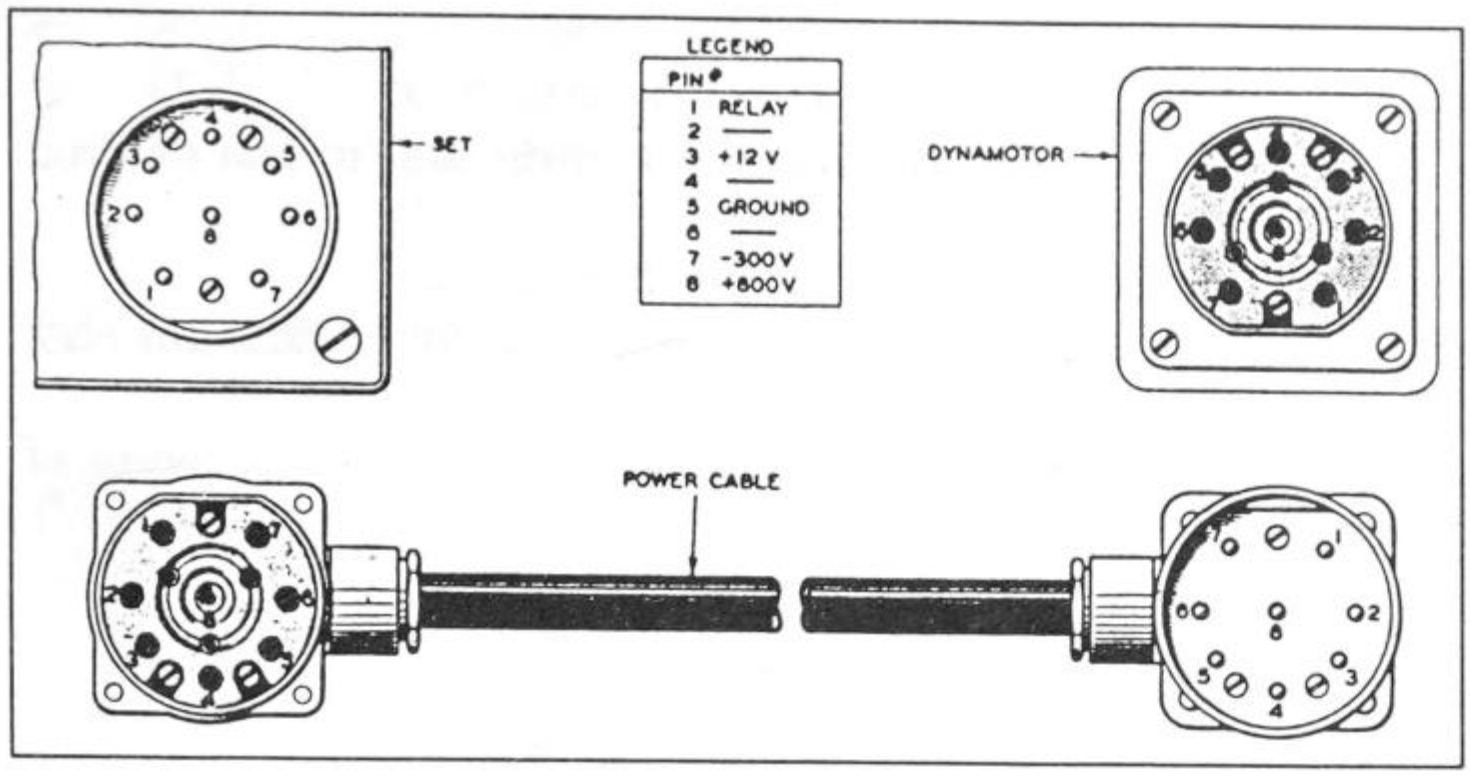


Figure 5.6 *Power cable connections between the set and the dynamotor. (Credit: U.S. Army)*

1. When the set is used in a vehicle, install a 16-foot vehicular antenna and connect the lead-in to the *Ant.* binding post. Connect a heavy flexible conductor to the *G.* binding post and bond it securely to the vehicle chassis.
2. Use a vertical mast or a long-wire antenna when the set is used for ground operation. Connect the lead-in as in D1 above and connect the *G.* binding post to a counterpoise or good ground rod.

V. OPERATION

A. Tuning.

1. After the set has been installed as directed in IV, turn the control marked *Bereichschalter* to the desired range and turn the dial to the selected frequency with the knob marked *Frequenzeinstellung.* Frequency in kilocycles = dial reading x 10.
2. Set the main switch to *Tg.* and wait one minute for the tubes to heat.
3. Set the high-low power switch to the 10W (10 watt) position and close the key.
4. Check the filament and plate voltages with the voltmeter on the panel. The filament voltage should be 12 volts as indicated by the red mark on the meter dial, and the plate voltage should be 800 volts as indicated by the blue mark on the meter dial. Press the small button on the voltmeter to read the plate voltage.
5. Set the *Ant. Kopplung* control to position 3 and the *Ant. Abst. Fein* control to its central position.
6. Adjust the *Ant. Abst. Gross* control for the highest reading on the antenna meter, and adjust the *Ant. Abst. Fein* control for maximum meter reading. If a maximum but not peak meter reading is obtained with the *Ant. Abst. Fein* control in the extreme right (or left) position, the *Ant. Abst. Gross* control should be set to the right (or left) one point. In either case, make the final adjustment with the *Ant. Abst. Fein* control.
7. Try to improve the output by adjusting the *Ant. Kopplung* control and then adjusting the *Ant. Abst. Fein* control. Once the *Ant. Kopplung* control is adjusted for maximum output, it will require no further adjustment when the frequency is changed, provided the same antenna is used.
8. Set the high-low power switch to the 80W (80 watt) position and make a final adjustment of the *Ant. Abst. Fein* control. The set is now ready to operate on either high or low power.

B. CW Operation.

1. For CW operation, set the *Bereichschalter* control and the tuning dial to the desired frequency, and set the high-low power switch for the output wanted.
2. Set the main switch to *Tg.* and wait one minute for the tubes to heat.
3. Press the key and adjust the *Ant. Abst. Fein* control for maximum output.

C. Voice Operation.

1. For voice operation, set the *Bereichschalter* control and the tuning dial to the desired frequency.
2. Set the main switch to *Tn.* and wait one minute for the tubes to heat.
3. Press the microphone switch and adjust the *Ant. Abst. Fein* control for maximum output.
4. Speak into the microphone and observe the antenna meter. A slight upward swing of the pointer indicates that modulation is taking place.

VI. CALIBRATION

A. Frequency Check.

1. Release the cover plate labelled *Frequenzkontrolle*, swivel it 90 degrees to the left, and plug a headset into the calibration jack.
2. Set the main switch to *Tn.* and set the high-low power switch to 10W (10 watts). Allow the tubes to warm up for at least five minutes.
3. Blue calibration marks are provided on the dial scales at the points in the following table.

Band I: 1,164 kilocycles and 1,552 kilocycles
Band II: 1,552 kilocycles and 1,940 kilocycles
Band III: 2,328 kilocycles and 2,716 kilocycles

4. Press the microphone switch and listen in the headset for a beat note at each of the calibration marks. If a zero beat is not obtained at or very near each mark, the set should be calibrated.

B. Calibration Reset.

1. Set the *Bereichschalter* to the band to be calibrated and set the tuning dial to the blue mark indicating the higher frequency.
2. Uncover the calibration capacitors and adjust the capacitor, corresponding to the position to which the *Bereichschalter* is set for zero beat. Repeat for each band if necessary, checking for another zero beat at the calibration mark on the low frequency end of the dial.
3. Set the main switch to *S.-Aus* (transmitter off), remove the headset, and replace the two cover plates.

VII. MAINTENANCE. Detailed maintenance instructions for this set are not included. The operator should observe the following simple precautions when the set fails to operate.

A. Check all cords, plugs, and connections. The most common faults are in the cording and connections.

B. Check the condition of the battery and dynamotor with the voltmeter on the panel by reading the filament and plate voltage as described in paragraph VA4 above.

C. If no plate voltage is indicated on the voltmeter, loosen the red-ringed retaining screws in each corner of the panel. Remove the set from its case and check the fuse located behind and below the antenna meter. *Ersatzsicherungen* are mounted behind the antenna meter.

CAUTION: This set uses high voltages that are dangerous to life. Exercise extreme care when making measurements inside the set with the power on.

D. If the condition of the tubes is questionable, replace them one at a time and check the operation after each replacement. If sidetone is present at the jack marked *z. Empf.*, the modulator tubes are functioning properly.

NOTE: Some type RL12P35 tubes have three caps on top; others only two. The third cap is a protecting cover for the exhaust seal tip and does not connect to any tube element.

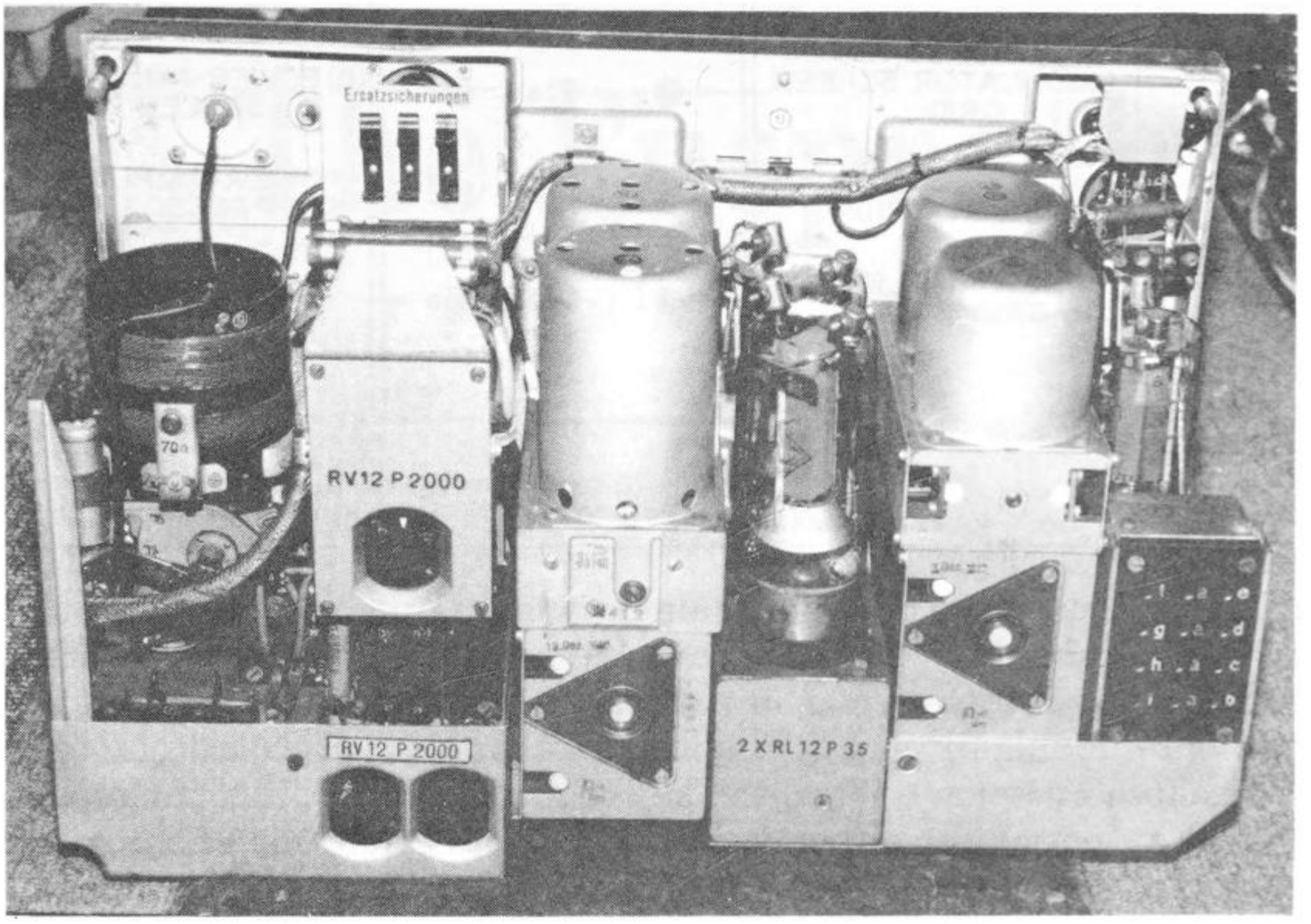


Figure 5.7 *Rear view of the 80 W.S.a removed from its case. Note the test panel at lower right.*

E. The following table lists the voltages that may be measured with a test voltmeter at the test panel on the back of the chassis (see Figure 5.7). All voltages are approximate and are measured between any terminal marked a (chassis) and the other terminals.

Terminal	CW		Voice	
	Key open	Key closed	Microphone switch open	Microphone switch closed
a	0	0	0	0
b	+12	+12	+12	+12
c	0	0	-330	-250
d *	+35	+30	+35	+28
d **	+425	+200	+425	+180
e *	+35	+30	+35	+28
e **	+425	+200	+425	+180
f	-300	0	-300	0
g	+300	+100	+300	+60
h	+100	+65	+100	+65
i	-290	-75	-290	-75

* 80W 10W high-low power switch at 10W
** 80W 10W high-low power switch at 80W

F. If the storage battery, dynamotor, and power cable have been checked and are known to be good and the set fails to operate, make the voltage measurements tabulated in E above using the values in the table above as a guide. (See also Figure 5.8.)

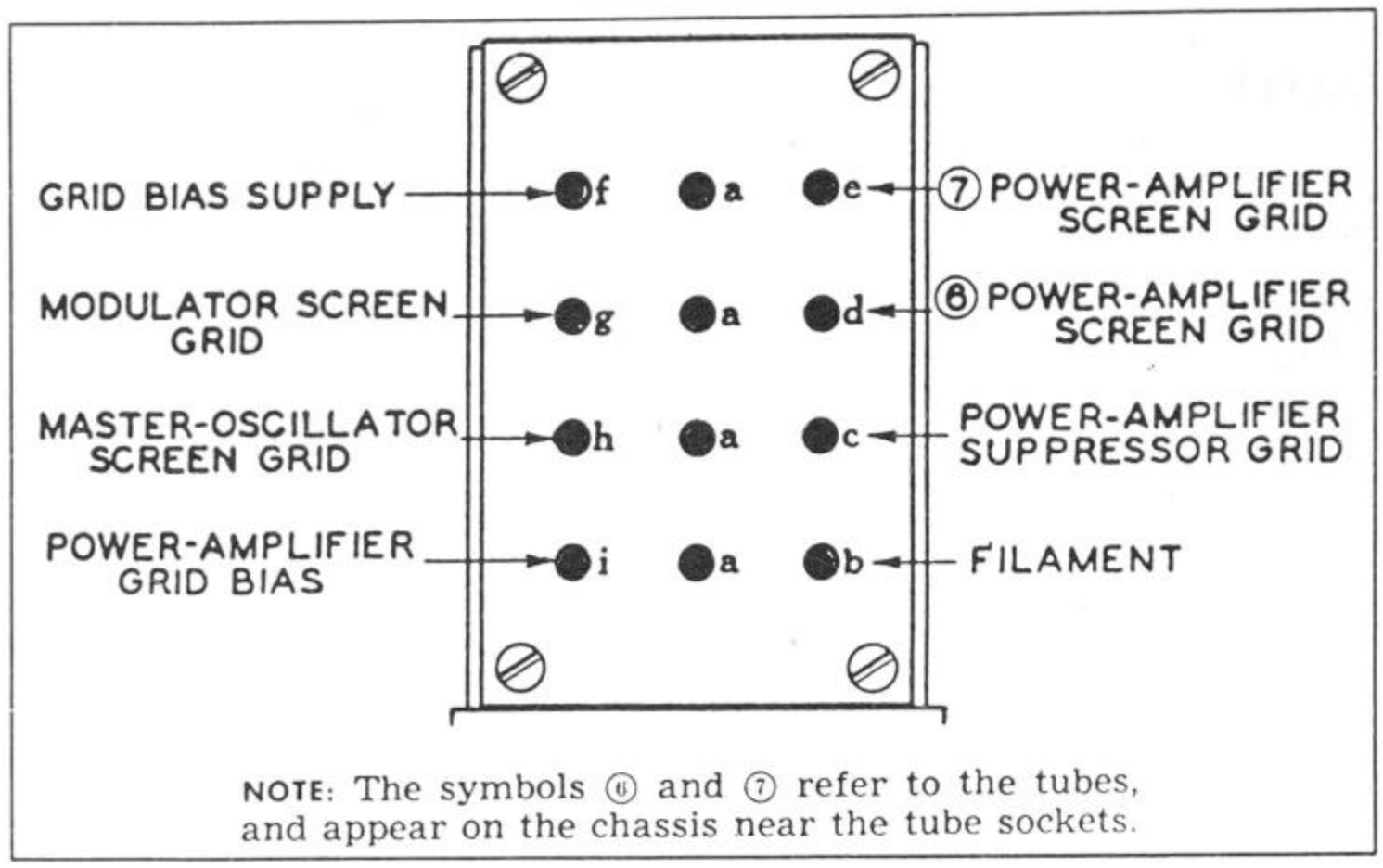


Figure 5.8 *Test panel of the 80 W.S.a. (Credit: U.S. Army)*

1. No voltage at terminal "b" indicates a defective main switch or faulty wiring in the set.
2. Low or zero voltage at terminal "c" during voice operation indicates either shorted capacitors, open resistors, an open transformer, or a defective main switch.
3. Low or zero voltage at terminals "d" and "e" indicates either shorted capacitors, open resistors, or an open fuse (see F5 below). When the key or microphone switch is closed, a voltage reading higher than normal at either terminal indicates that one of the lower amplifier tubes is defective.
   a) Tube 6 is defective if a high voltage reading is obtained at terminal "d."
   b) Tube 7 is defective if a high voltage reading is obtained at terminal "e."
   c) The set will operate at reduced power with a defective power-amplifier tube provided the tube is not shorted.
4. Low or zero voltage at terminal "f" indicates either shorted capacitors or open resistors. If the voltage does not drop to zero when the key or microphone switch is closed, the keying relay is defective.
5. Low or zero voltage at terminals "g" or "h" indicates either shorted capacitors, open resistors, or an open fuse. When zero voltage is indicated at terminals "d" and "e" as well as at terminals "g" and "h," replace the fuse. If the voltage is still zero, send the set back to a signal depot.
6. Low or zero voltage at terminal "i" indicates either shorted capacitors or open resistors. When the key or microphone switch is closed, a very low or zero voltage indicates weak or defective power-amplifier tubes.
7. When the tests described above show such defects as open resistors, shorted capacitors, an open transformer, a defective relay, or faulty wiring, send the set back to a signal depot.

CHAPTER 6

The Fusprech a.d.f

I. DESCRIPTION

A. The Set. The *Fusprech a.d.f* (radiotelephone models a, d, or f) is a high-frequency transceiver used for communication between reconnaissance cars, and between reconnaissance cars and reconnaissance tanks. The *Fusprech* is used only for voice communication, and is also capable of transmitting a tone signal for calling other operators. The set is contained in a metal case with a leather carrying strap. It is a very compact unit employing seven tubes, all of which are used when the set functions as a receiver, and three of which are used when the set functions as a transmitter. The nameplate of the *Fusprech* is shown in Figure 6.1.

Figure 6.1 *Nameplate of the Fusprech a. (Credit: U.S. Army)*

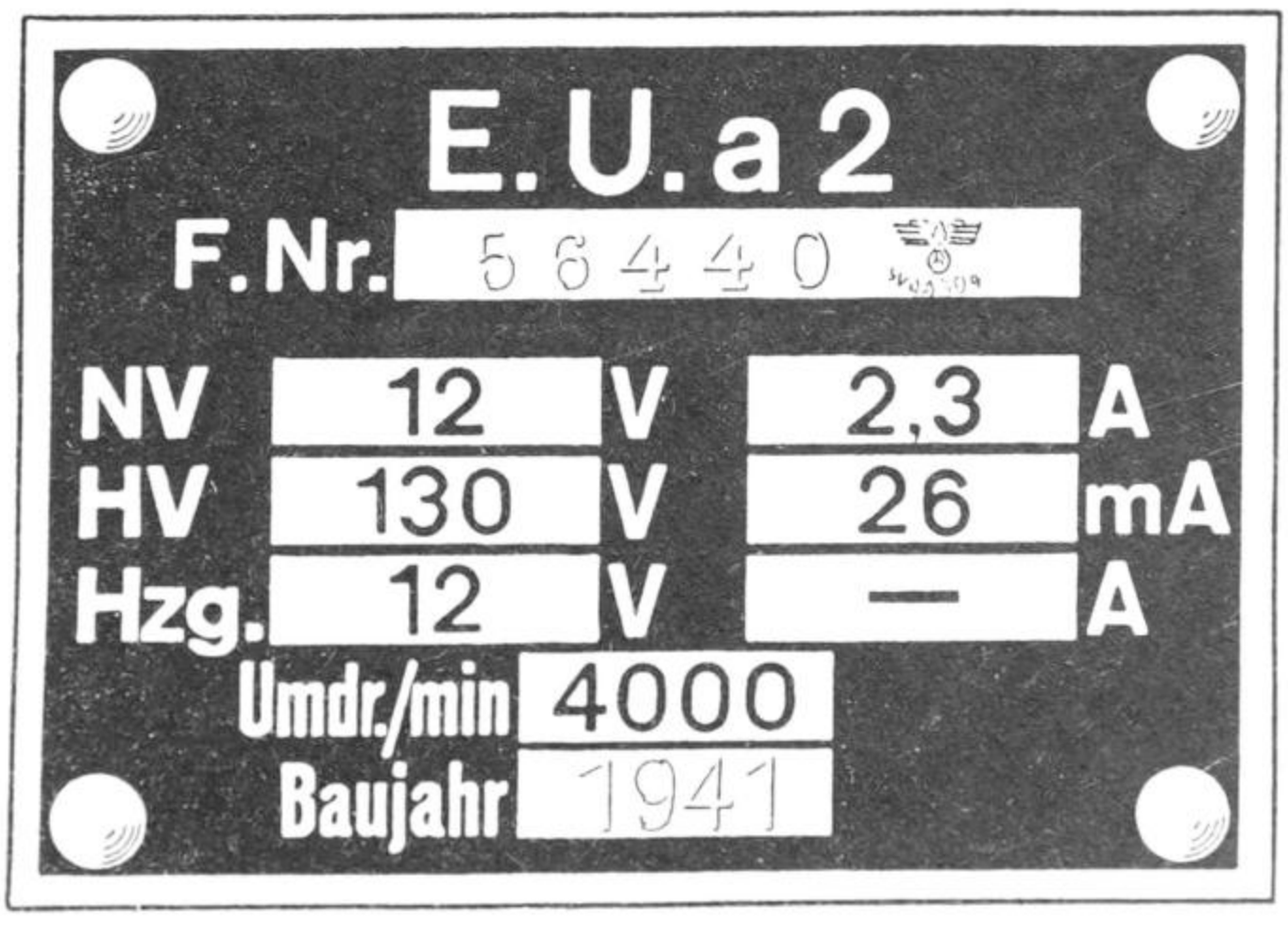


Figure 6.2 *Nameplate of the E.U.a2 dynamotor. (Credit: U.S. Army)*

B. Power Supply. Power is supplied by the vehicular storage battery through the dynamotors E.U.a (receiver dynamotor

model a), E.U.a2 (receiver dynamotor model a2), S.E.U.a (transmitter-receiver dynamotor model a), or any dynamotor unit having the necessary power output. The nameplate of dynamotor E.U.a2 is shown in Figure 6.2. These units are very similar in construction and differ chiefly in minor operating characteristics and output capabilities. They are contained in rugged cases of cast lightweight alloy construction. Dynamotor E.U.a2 is shown in Figure 6.3.

Figure 6.3 *The E.U.a2 dynamotor.*

1. Dynamotors E.U.a2 and E.U.a are provided with a two-terminal input receptacle at one end of the case and a five-connector output receptacle at the other end. The E.U.a2 contains a starting relay that is used for connecting the input voltage to the dynamotor. The starting relay is operated when the *Aus Ein* (off on) switch on the set is placed in the *Ein* position. The number 3 contact in the power receptacles and plugs is used to supply the necessary operating voltage. The dynamotor E.U.a does not contain a starting relay, but input voltage is conducted through the same path as the relay-energizing voltage described above. For circuit identification, a schematic diagram is mounted inside the dynamotor cover.

2. Dynamotor S.E.U.a is similar to dynamotors E.U.a2 and E.U.a in operation and construction, except that at one end of the case there is a two-terminal input receptacle and a five-connector output receptacle. The output capabilities of dynamotor S.E.U.a are greater than those of dynamotors E.U.a2 and E.U.a and it therefore can be used to operate a receiver or small transmitter that has requirements within the ratings.

II. PERFORMANCE DATA. The following table lists the performance data of the transceiver.

Frequency range
(transmitting or receiving): 24.1 to 25.0 megacycles

Types of signals emitted: tone for signaling

Types of signals that can be received: tone, voice

Types of modulation: amplitude

Method of modulation: grid

Preset frequencies: none

Antenna type: rod, 6 1/2 feet

Distance range: approximately 3 1/2 miles

Dial graduation: 10 numbered channels

Dial Number	Frequency
101	24.1 megacycles
102	24.2 megacycles
103	24.3 megacycles
104	24.4 megacycles
105	24.5 megacycles
106	24.6 megacycles
107	24.7 megacycles
108	24.8 megacycles
109	24.9 megacycles
110	25.0 megacycles

Type of transmitter: master oscillator-power amplifier (MOPA)

Type of receiver: superheterodyne

Number of tubes: 7 (as listed below)

Type of tube	Receiving function	Transmitting function
1 RV12P2000	mixer	
1 RV12P2000	h-f oscillator	master oscillator
1 RV12P2000	first i-f amplifier	
1 RV12P2000	second i-f amplifier	
1 RV12P2000	detector	
1 RV12P2000	first a-f amplifier	modulator and tone oscillator
1 RL12Pl0	a-f output	power amplifier

Intermediate frequency: approximately 1.5 megacycles

H-f oscillator frequency: 1.5 megacycles below signal frequency

Sidetone in set: none

Zero beat transmitter with receiver impossible

Power output: 8 watts

Power supply: 12-volt vehicular storage battery

Power requirements
Filaments: approximately 12 volts, 1 ampere
Plates: approximately 130 volts 25 milliamperes to 180 volts 85 milliamperes

Current drain from 12-volt battery: approximately 5.5 amperes

III. INSTALLATION

A. Location. Mount the transceiver and dynamotor securely in suitable mounting racks. If racks are not provided in the vehicle, firm supports for the equipment will have to be constructed.

B. Cording.

CAUTION: Before making any connections, be sure the control marked *Aus-Ein* is in the *Aus* position.

1. Connect the battery lead to the 12-volt input terminals of the dynamotor and the 12-volt storage battery, inserting a 15-ampere fuse in the positive lead.
2. Connect the power cable to the power-input receptacle on the lower left of the front panel of the transceiver and to the power-output receptacle on the dynamotor, as shown in Figure 6.4.

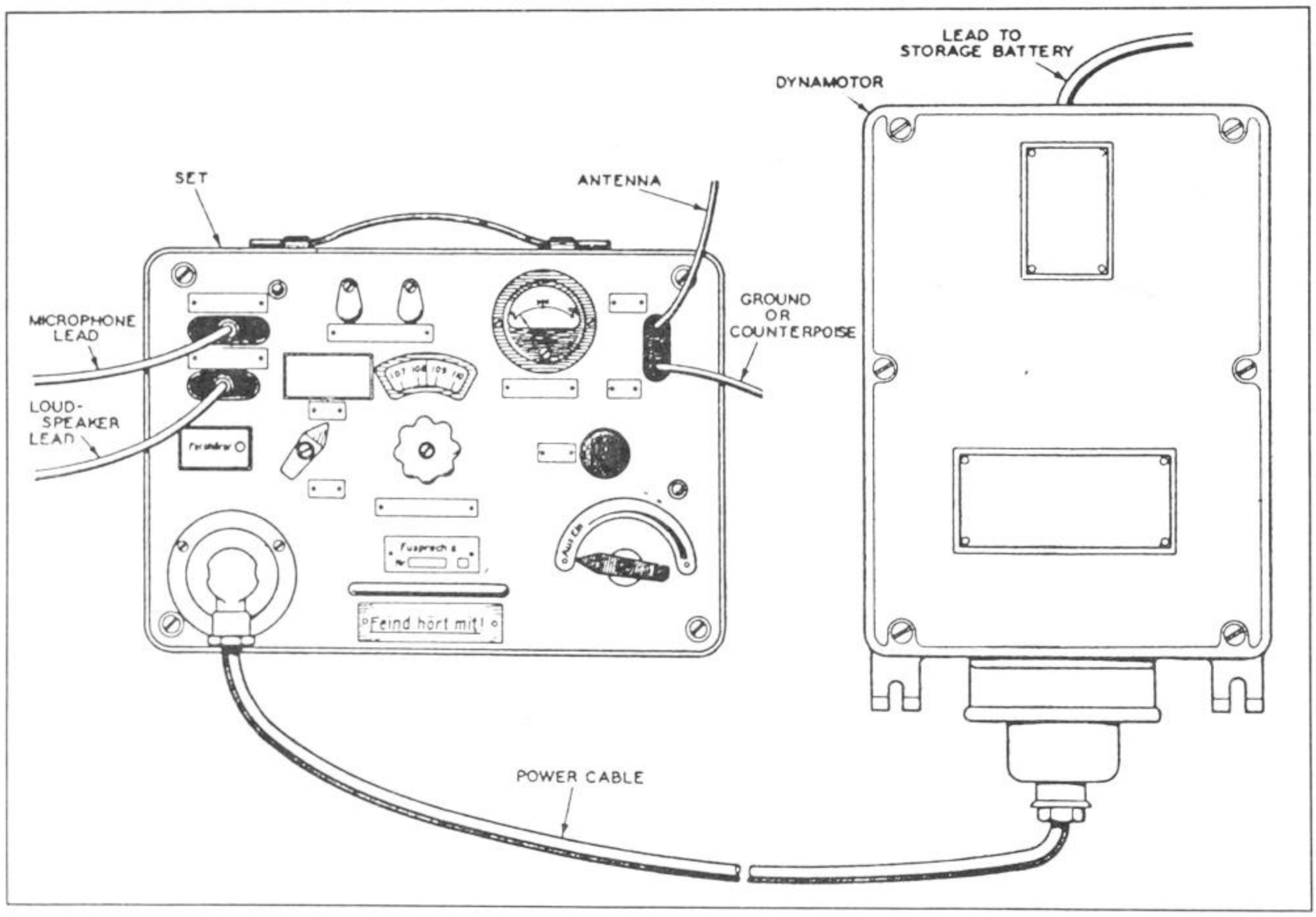


Figure 6.4 Cabling diagram for the Fusprech a. (Credit: U.S. Army)

3. Connect the antenna cable to the jack marked *Ant.* Ground the jack marked *G.* to the chassis of the vehicle (see Figure 6.4). If coaxial cable is available, connect the center conductor to the jack marked *Ant.* and the shield to the jack marked *G.* Ground the shield to the vehicle chassis.
4. Plug the microphone lead into the jack labeled *Mikrofon*. Any single-button carbon microphone that will plug into the jack is satisfactory.
5. Plug the loudspeaker into the jack marked *Lautsprecher* (loudspeaker), making sure that the jack cover marked *Fernhorer* covers the headset jack. The loudspeaker will not function if the headset-jack cover is open. If headset operation is desirable, uncover the

headset jack and plug in the headset. Any headset with a suitable plug will do. The set is now ready for operation.

IV. OPERATION

A. After the set is installed, turn the main switch and volume control marked *Aus-Ein* to the *Ein* position. Allow about one minute for the tubes to warm up.

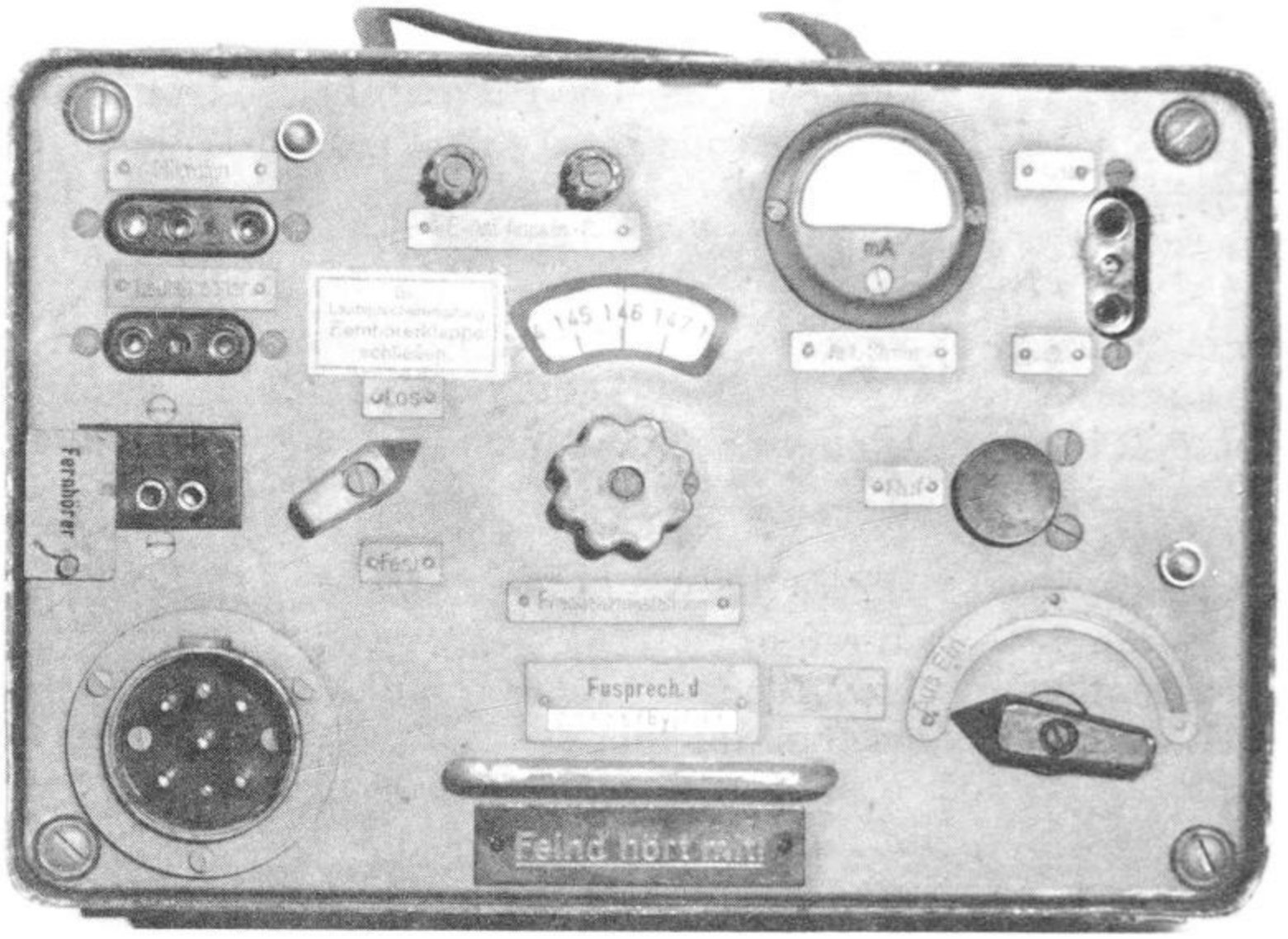


Figure 6.5 *Front view of a Fusprech d. The only difference between the various Fusprech sets is the frequency ranges.*

B. Turn the dial lock, marked *Los* and *Fest*, to the *Los* position, as shown in Figure 6.5. Select the desired frequency by means of the control marked *Frequenzeinstellung*. Lock the tuning control by turning the dial lock to *Fest*.

C. Open the antenna-trimmer covers marked *E.-Ant. Anpass.-S.* (receiver and transmitter antenna trimmers). Press the switch on the microphone and, with a screwdriver, adjust the antenna trimmer marked *S.* (transmitter) for maximum reading on the meter marked *Ant.-Strom* (antenna current).

NOTE: Pressing the microphone switch puts the transmitter carrier on the air. When the button is released, the set functions as a receiver.

D. With either the loudspeaker or the headset plugged in, adjust the antenna trimmer marked *E.* (receiver) for maximum signal strength in the loudspeaker or headset.

E. To transmit, press the microphone switch and speak into the microphone.

F. When receiving, adjust the volume of the signal in the headset with the control marked *Aus-Ein*.

G. To call another operator, press the microphone switch and the button on the front panel of the transmitter labeled *Ruf* (call). Pressing the microphone switch puts the carrier on the air, and pressing the call button causes the tone oscillator to oscillate and tone-modulate the transmitted signal. These operations cause a loud howl to be produced in the loudspeakers of the sets receiving this signal.

V. MAINTENANCE. Detailed maintenance instructions are not included in this chapter. If the set fails to operate, follow the general instructions given below:

A. Check the battery voltage with the set turned on.

B. If the dynamotor does not run, check the fuse.

C. Check all cords, plugs, and connections.

D. When the set is receiving, all the tubes are in operation. Therefore, if the receiver is functioning properly and the meter labeled *Ant.-Strom* indicates that the transmitter is not operating, the tubes are probably not the source of trouble. Check the microphone lead, connectors, and microphone switch.

E. If the set does not receive or transmit, replace and test the following tubes in the order given: power amplifier, master oscillator, and modulator. If the set still does not transmit, the trouble is not in the tubes. If transmitter operation is normal and reception is impossible, see G below.

F. To change the tubes, remove the set from the case. Loosen the four retaining screws on the front panel of the set (see Figure 6.5). Each retaining screw is encircled with a red ring. Then pull the set from the case. Figure 6.6 is a top and rear view of the set with the case removed and shows the position and function of all the tubes.

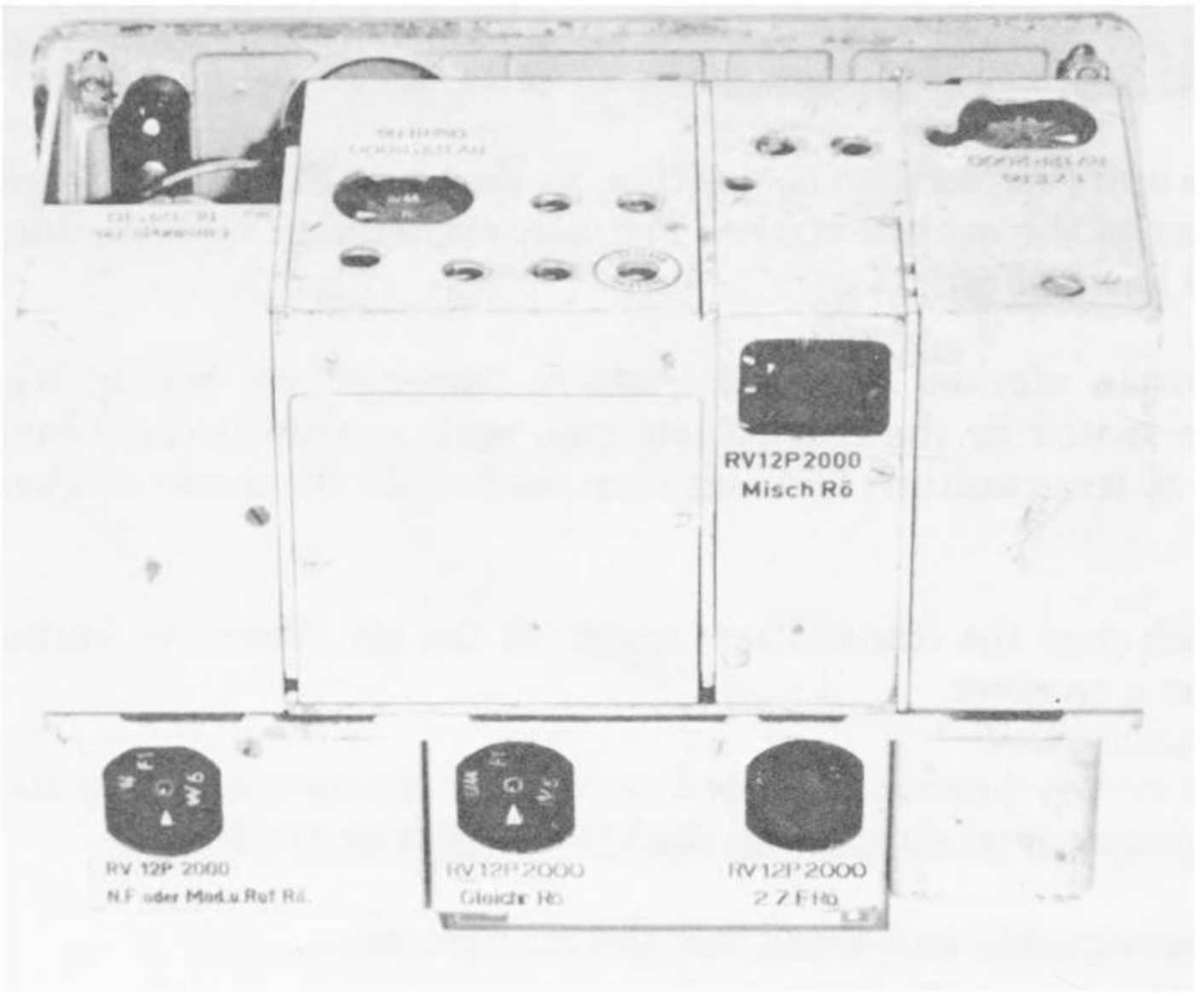


Figure 6.6 *Top and rear view of a Fusprech d.*

G. If the antenna meter indicates that the transmitter is functioning properly, and the receiver is inoperative, replace the following tubes in the order given: detector, second i-f amplifier, first i-f amplifier, and mixer.

H. To remove any tube not having a knob, unscrew a knob from another tube and screw it into the hole in the base of the tube to be removed. Be sure that no knobs are left on any of the tubes on the top of the chassis when the chassis is replaced in its case.

I. If the simple procedures outlined above do not make the set operate, send it back to a signal depot. The components may be used to repair other sets.

Figure 6.7 *A Fusprech d with hand microphone and headphones.*

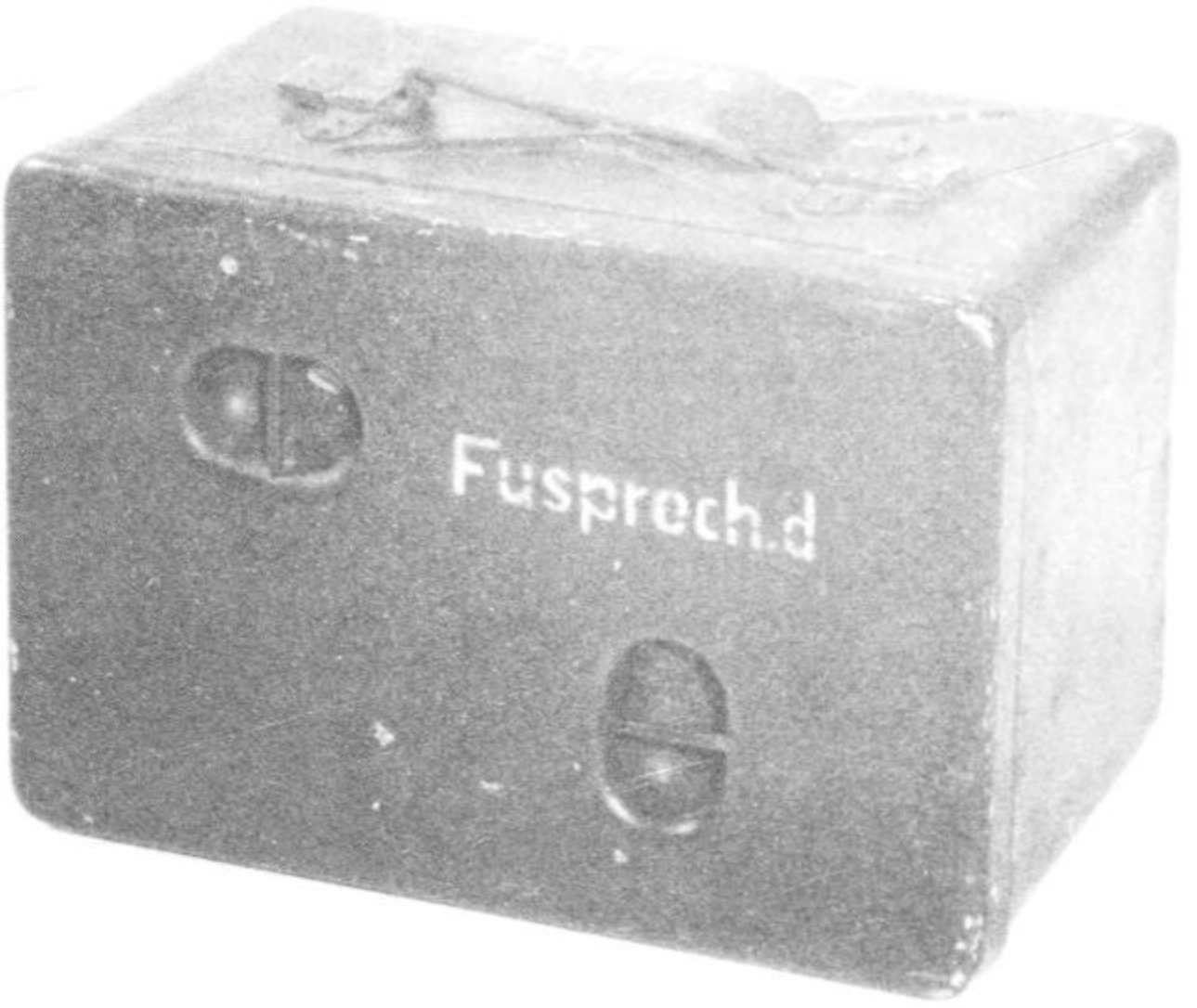


Figure 6.8 *A Fusprech d radio set with the cover plate installed. The cover is held in place by two spring-loaded clips.*

CHAPTER 7

The Torn. Fu.g

I. DESCRIPTION

A. The Set. The Torn. Fu.g (portable radio set g) is a transmitter-receiver combination capable of *Telegrafie* and *Telefonie* operation. The nameplate that identifies the set is shown in Figure 7.1. The set is contained in a weatherproof metal case, on the top of which is a carrying handle and a socket for mounting the antenna. Three carrying-strap connectors and two ring-eyes are also provided for strapping the set to an operator's back. On the bottom of the case is a strap and clip for fastening the small accessories bag. Clips are provided to carry the whip antenna on the outside of the case.

Figure 7.1 *Nameplate of the Torn. Fu.g. (Credit: U.S. Army)*

B. Accessories.

1. The accessories compartment contains the following items:
   a) 1 2.4-volt nickel-iron storage battery, German type 2.4NC28.
   b) 1 antenna base, German type g.
   c) 4 antenna sections, German type g.
   d) 1 antenna tuning coil, German type g.
   e) 1 headset, German type f.
   f) 1 telegraph key, German type TKP.
2. The accessories carried in the small bag (*Fu.*) are as follows:
   a) 1 throat microphone, German type c.
   b) 1 remote cable, German type c.
   c) 1 counterpoise.
   d) 1 headset, German type f.

II. PERFORMANCE DATA. The following table lists the general characteristics and performance data of the Torn. Fu.g.

Frequency range
Transmitting: 2,500 kilocycles to 3,500 kilocycles
Receiving: 2,500 kilocycles to 3,500 kilocycles

Preset Frequencies: none

Types of signals emitted: CW and voice

Type of signals that may be received:
CW, voice, and tone

Type of modulation: amplitude

Method of modulation: suppressor grid

Distance Range
CW: approximately 16 miles
Voice: approximately 7 miles

Antenna type
Stationary operation: 4-section rod with tuning coil and umbrella top
Portable operation: whip antenna with tuning coil and rod with tuning coil

Dial graduation: kilocycles

Number of dial divisions: 100

Kilocycles per division: 10

Type of transmitter: master oscillator-power amplifier (MOPA)

Type of receiver: superheterodyne

Number of tubes: 7

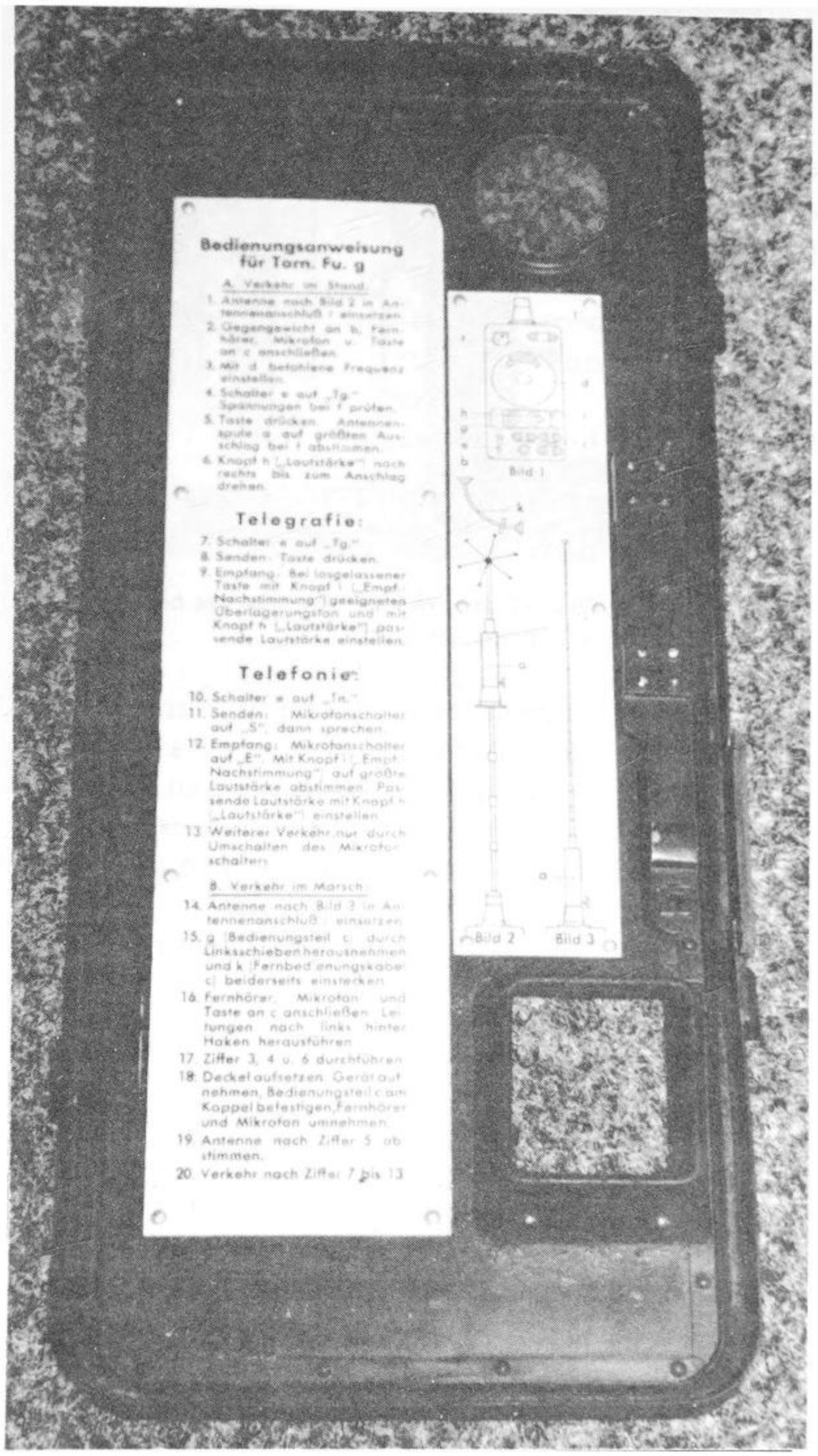
Type of tube	Receiving function	Transmitting function
RV2.4P700	r-f amplifier	none
RV2.4P700	converter	none
RV2.4P700	detector	sidetone amplifier for voice
RV2.4P700	a-f amplifier	sidetone amplifier for voice and sidetone oscillator for CW
RL2.4P3	none	master oscillator
RL2.4P3	none	power amplifier

Power output
CW.: 1 watt nominal
Voice.: 0.5 watt nominal

Type of CW oscillator: regenerative detector

Zero beat transmitter with receiver impossible

Power supply: 2.4-volt storage battery type 2.4NC28
through synchronous vibrator


Bedienungsanweisung
für Torn. Fu. g
A. Verkehr im Stand.
1. Antenne nach Bild 2 in Antennenanschluß f einsetzen.
2. Gegengewicht am b, Fernhörer, Mikrofon u. Taste an c anschließen.
3. Mit d befohlene Frequenz einstellen.
4. Schalter e auf „Tg." Spannungen bei f prüfen.
5. Taste drücken. Antennenspule a auf größten Ausschlag bei f abstimmen.
6. Knopf h („Lautstärke") nach rechts bis zum Anschlag drehen.
Telegrafie:
7. Schalter e auf „Tg."
8. Senden: Taste drücken.
9. Empfang: Bei losgelassener Taste mit Knopf i („Empf. Nachstimmung") geeigneten Überlagerungston und mit Knopf h („Lautstärke") passende Lautstärke einstellen.
Telefonie:
10. Schalter e auf „Tn."
11. Senden: Mikrofonschalter auf „S", dann sprechen.
12. Empfang: Mikrofonschalter auf „E". Mit Knopf i („Empf. Nachstimmung") auf größte Lautstärke abstimmen. Passende Lautstärke mit Knopf h („Lautstärke") einstellen.
13. Weiterer Verkehr nur durch Umschalten des Mikrofonschalters.
B. Verkehr im Marsch:
14. Antenne nach Bild 2 in Antennenanschluß f einsetzen.
15. g (Bedienungsteil c) durch Linksschieben herausnehmen und k (Fernbedienungskabel c) beiderseits einstecken.
16. Fernhörer, Mikrofon und Taste an c anschließen. Leitungen nach links hinter Haken herausführen.
17. Ziffer 3, 4 u. 6 durchführen.
18. Deckel aufsetzen. Gerät aufnehmen, Bedienungsteil c am Koppel befestigen, Fernhörer und Mikrofon umnehmen.
19. Antenne nach Ziffer 5 abstimmen.
20. Verkehr nach Ziffer 7 bis 13.
Bild 1
Bild 2
Bild 3

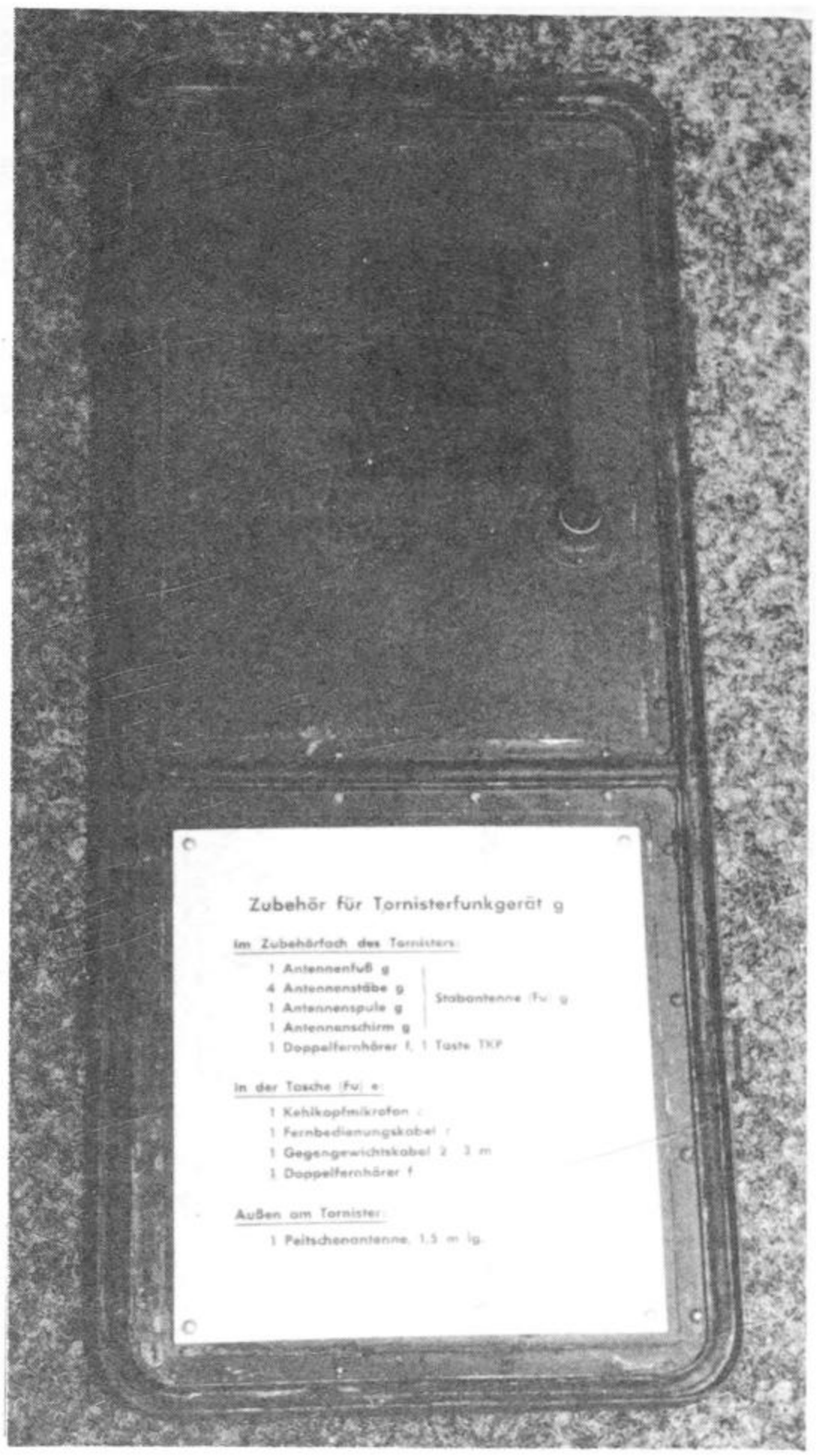


Figure 7.2 *(Left) Inside view of the front cover plate.*

Figure 7.3 *(Above) Inside view of the rear cover plate.*

III. INSTALLATION

A. Installation for Stationary Operation.

1. Remove the rear cover (Figure 7.3) and connect the leads, which are plainly marked (red +, blue -) to the 2.4NC28 battery. Place the battery in position (see Figure 7.4) and strap it firmly in place.
2. Determine the accessories required for the method of use and replace the cover.
3. Assemble the antenna as shown in Figure 7.5.

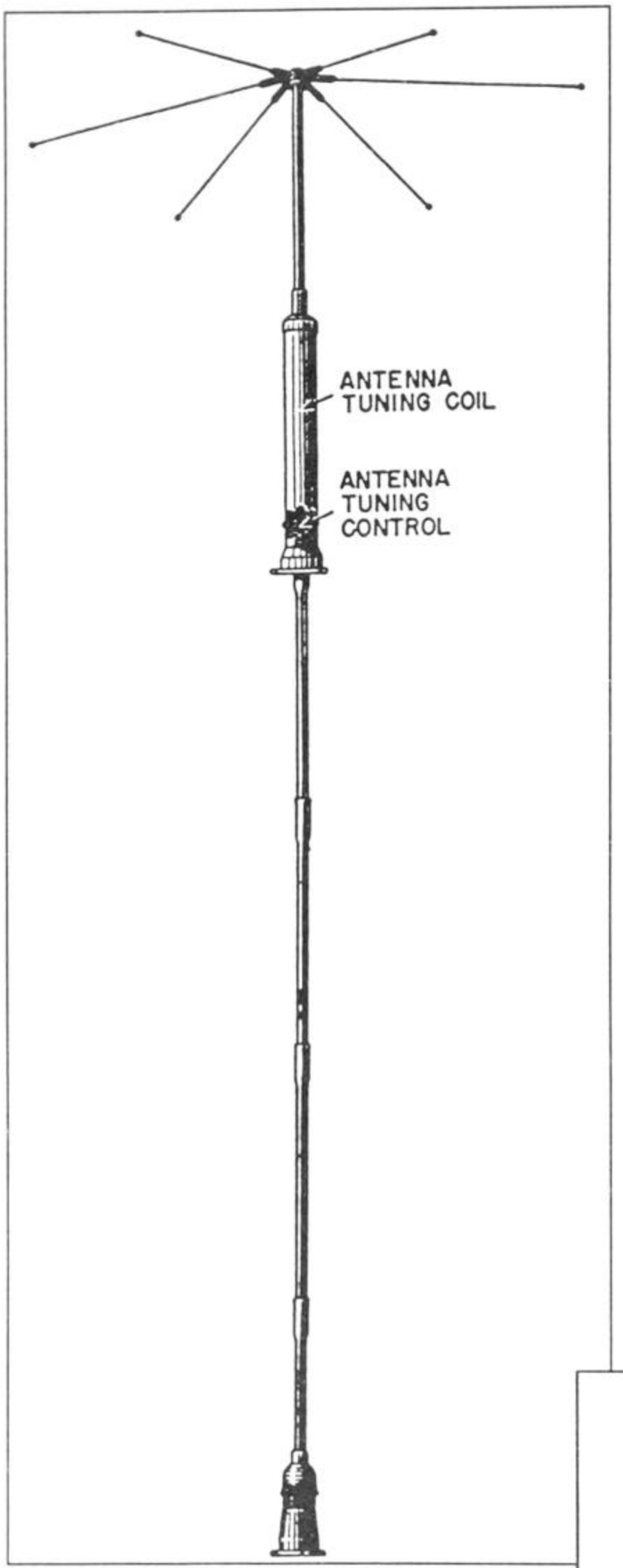


Figure 7.5 *The antenna set up for stationary operation. (Credit: U.S. Army)*

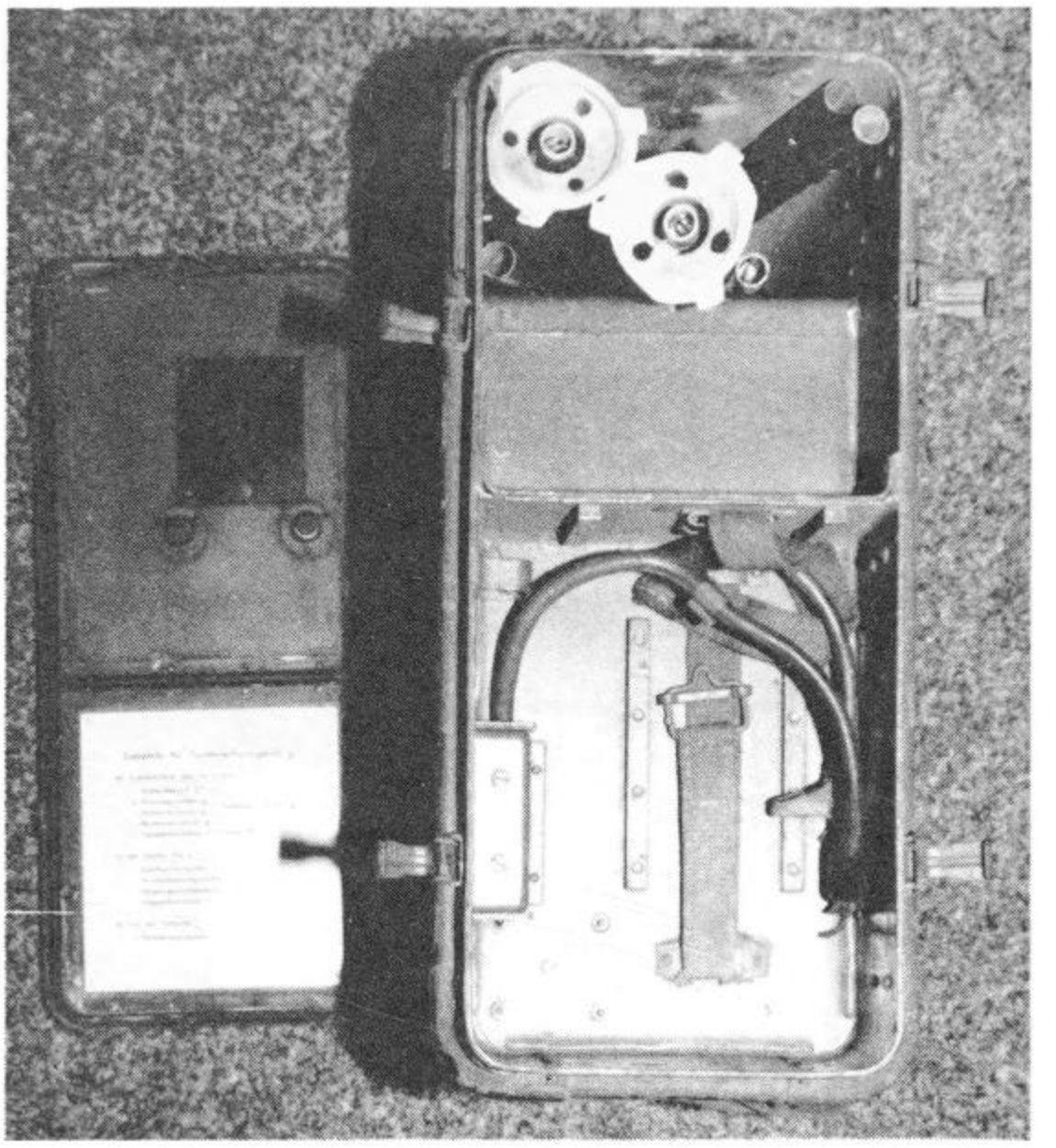


Figure 7.4 *Rear view of the set showing the battery storage and accessory compartment.*

4. Place the antenna base in the antenna socket on top of the set. Turn the antenna base to the right until it locks into position. (When dismantling, press the spring lever on the antenna socket in the direction of the red arrow and turn the antenna base to the left.)

5. Connect the counterpoise to the counterpoise binding terminal marked *G*.

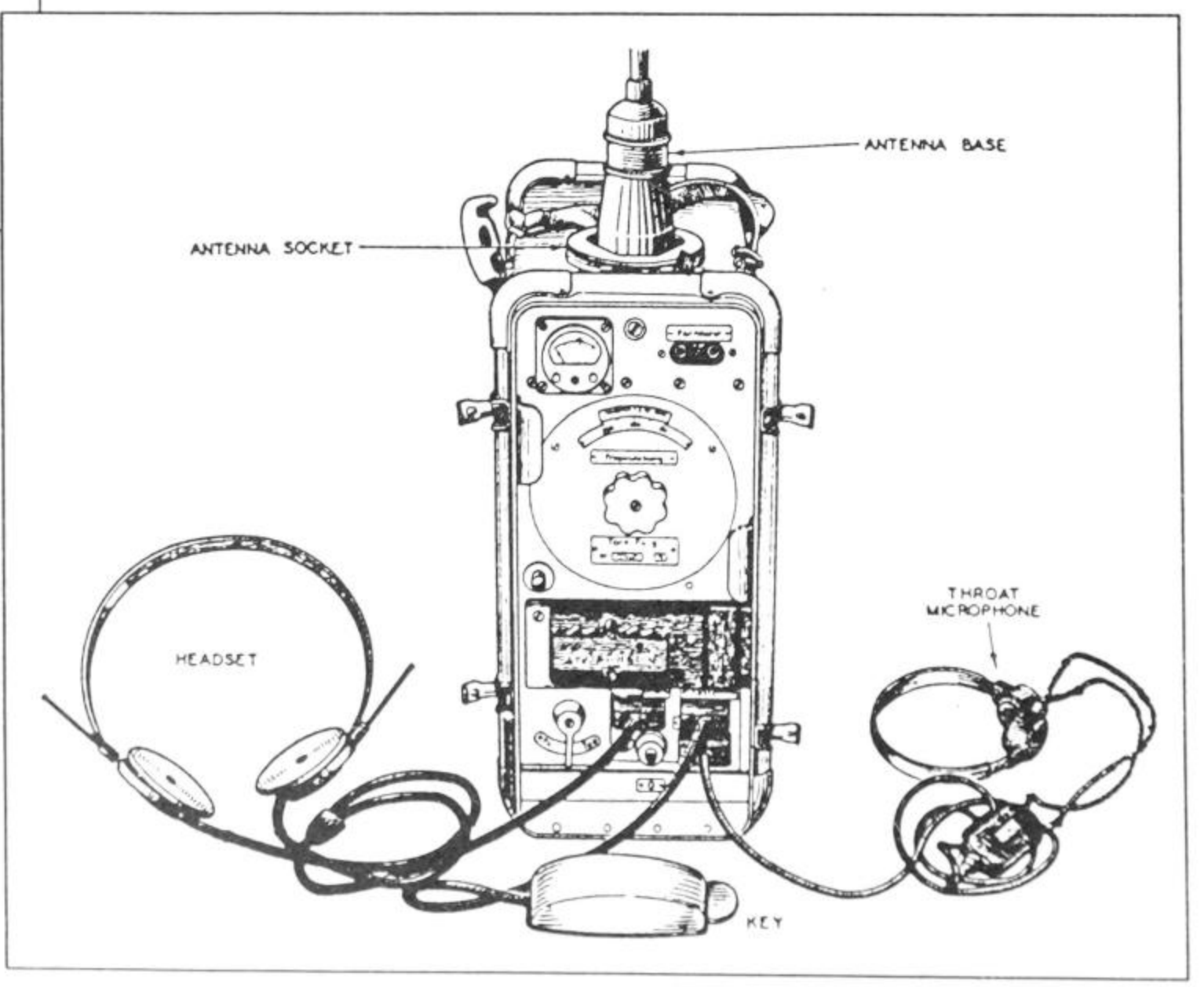


Figure 7.6 *The Torn. Fu.g set up for stationary operation. (Credit: U.S. Army)*

6. Plug the telegraph key into the jack marked *Taste*.

7. Plug the microphone into the jack marked *Mikrofon*. Place the throat microphone on the neck so that its leads hang downward and the microphone buttons lie flat against the throat.

8. Plug the headset into one of the jacks marked *Fernhorer*.

NOTE: Any telegraph key, single-button microphone (such as Signal Corps Microphone T-17), or high-impedance headset will work satisfactorily if equipped with suitable plugs.

9. When the set is installed for stationary use (see Figure 7.6), do not attempt operation with the front cover in place. A push-button switch at the left side of the front panel automatically turns the set off when the cover is in place, regardless of the position of the main switch. This push-button switch has no effect when the remote control unit is removed from the panel and connected through the remote cable.

B. Installation for Portable Operation.

1. Follow the directions in Al and A2 above.

2. Install the whip antenna as shown in Figure 7.5.

3. An antenna assembly as shown in Figure 7.7 should be used only in emergencies.

4. Remove the remote control unit from the panel by pushing it to the left. Connect it be means of the remote cable to the socket on the panel.

5. Connect the telegraph key, microphone, and headset (A6, A7, and A8 above). Bring out the leads to the left behind the hook on the remote cable.

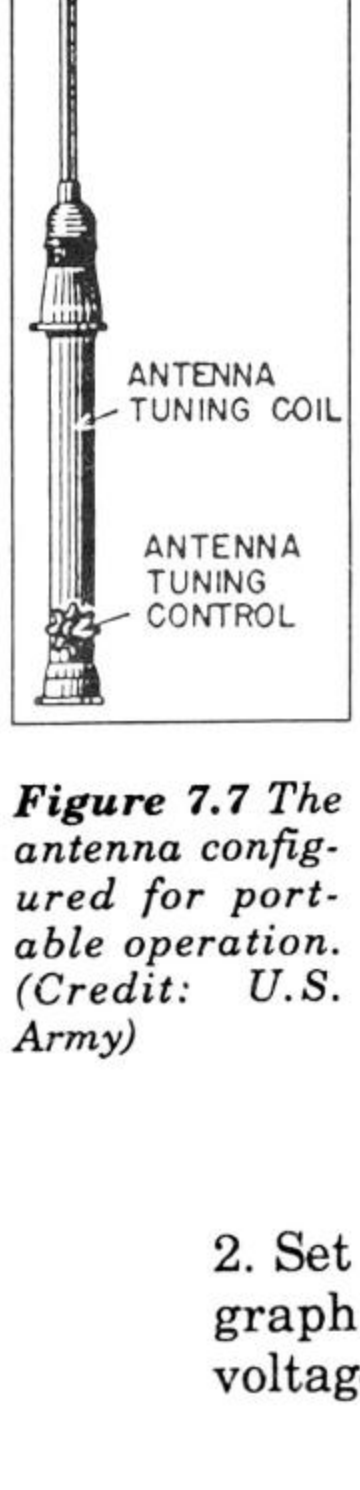


***Figure 7.7** The antenna configured for portable operation. (Credit: U.S. Army)*

IV. OPERATION. Begin operating the set after it is installed (III A above). Refer to Figure 7.8 for location of controls.

A. Tuning for Stationary Operation.

1. Set to the required frequency by means of the control marked *Frequenzeinstellung*.

2. Set the main switch to *Tg*. Depress the telegraph key and check the filament and plate voltages as follows:

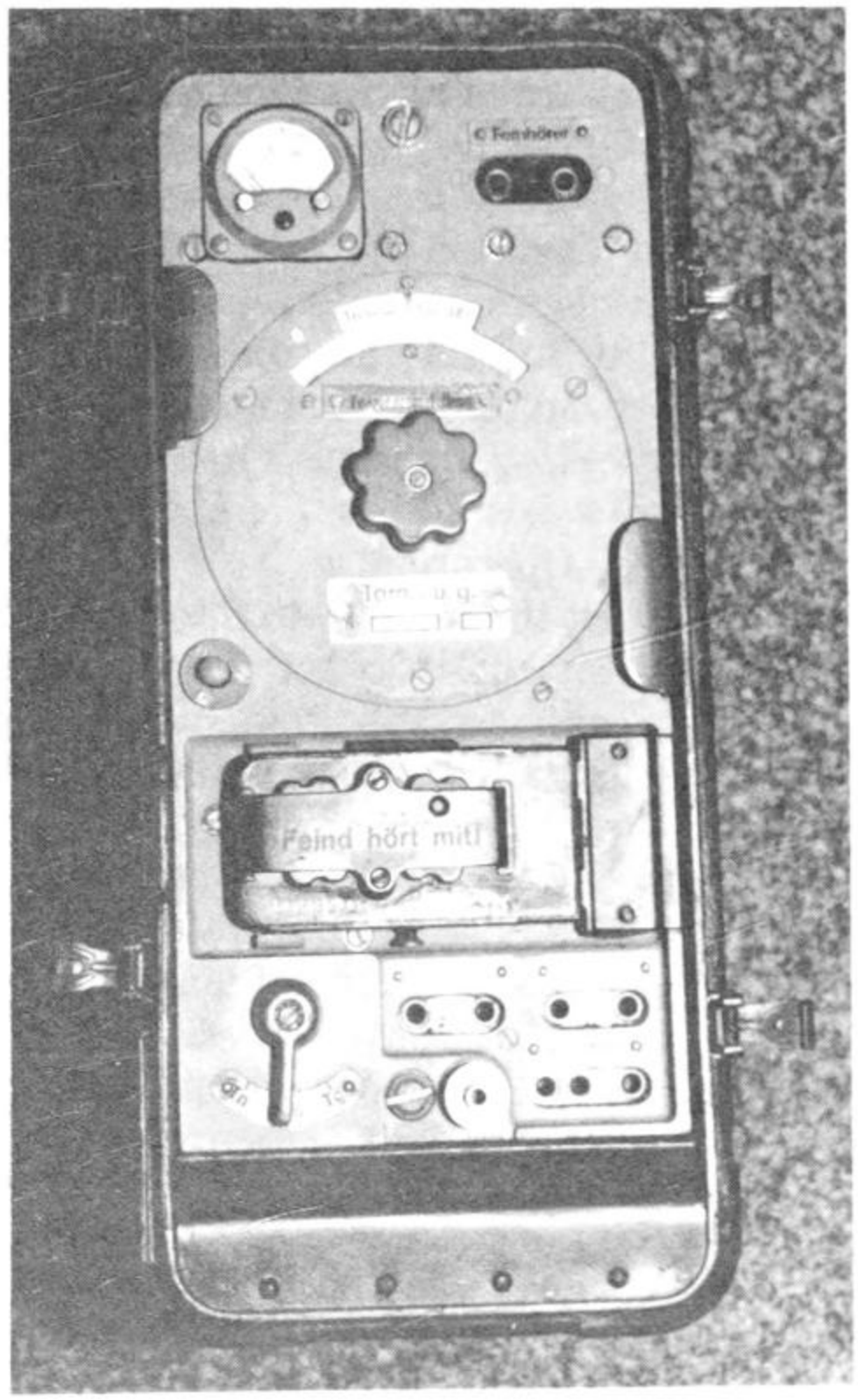


***Figure 7.8** Instrument panel of the set. From top to bottom: voltmeter, Fernhorer (headphone input jack), Teilstrich (tuning control dial), Frequenzeinstellung (tuning control knob), nameplate, remote control unit, main switch, Ferhorer (headphone input jack), Taste (Morse key input jack), Mikrofon (microphone input jack), counterpoise binding post.*

a) Press the red button on the meter to check the filament voltage. The meter indication should be within the red section of the scale.

b) Press the blue button on the meter to check the plate voltage. The meter indication should be within the blue section of the scale.

3. With the main switch in the *Tg.* position, depress the telegraph key and adjust the *Ant. Abst.* control on the antenna tuning coil for maximum deflection on the meter.

4. Turn the control marked *Lautstärke* on the remote control unit to the right as far as it will turn. Remote control remains on the front panel for stationary operation.

B. Tuning for Portable Operation.

1. Perform the operations described in Al, A2, and A4 above.

2. Put the covers on the set. Place and strap the set on the back. Attach the remote control unit to the belt at a position conveniently accessible with the left hand. Put on the headset and microphone.

3. Tune the antenna as described in A3 above.

CAUTION: The antenna must be tuned with the set strapped on the operator's back. If the set is removed for ground operation, the antenna must be retuned.

C. CW Operation.

1. Set the main switch to the *Tg.* position.

2. To transmit, use the telegraph key.

3. To receive, make sure the telegraph key is open and proceed as follows:

a) Tune in the required signal by means of the control marked *Empf.-Nachstimmung* on the remote control unit. Do not change the setting of the control marked *Frequenzeinstellung*.

b) Adjust the control marked *Empf.-Nachstimmung* to produce a beat note of the desired pitch in the headset.

c) Use the control marked *Laustärke* to vary the volume of the signal in the headset.

D. Voice Operation.

1. Set the main switch to the *Tn.* position.

2. To transmit, set the microphone switch (located in the microphone cord) to *S.* and speak.

3. To receive, set the microphone switch to *E.*

a) Tune for maximum volume from the required signal by means of the control marked *Empf.-Nachstimmung* on the remote control unit. Do not change the setting of the control marked *Frequenzeinstellung*.

b) Use the control marked *Lautstärke* to adjust the volume of the signal in the headset.

4. During conversation that is not to go out over the transmitter, set the microphone switch to the *E.* position.

5. When the set is not in use, turn the main switch to the *Aus* position.

V. CALIBRATION

A. Receiver. When the station cannot be tuned in by means of the *Empf.-Nachstimmung* control, it will be necessary to adjust the receiver calibration trimmer (see Figure 7.9). Proceed as follows:

1. Loosen the two red-ringed retaining screws and pull the set from the case.

2. Extend the connections from the battery plug in the case to the power-input socket on the back of the set so that it will operate out of the case.

3. Set the *Empf.-Nachstimmung* control to its midpoint.

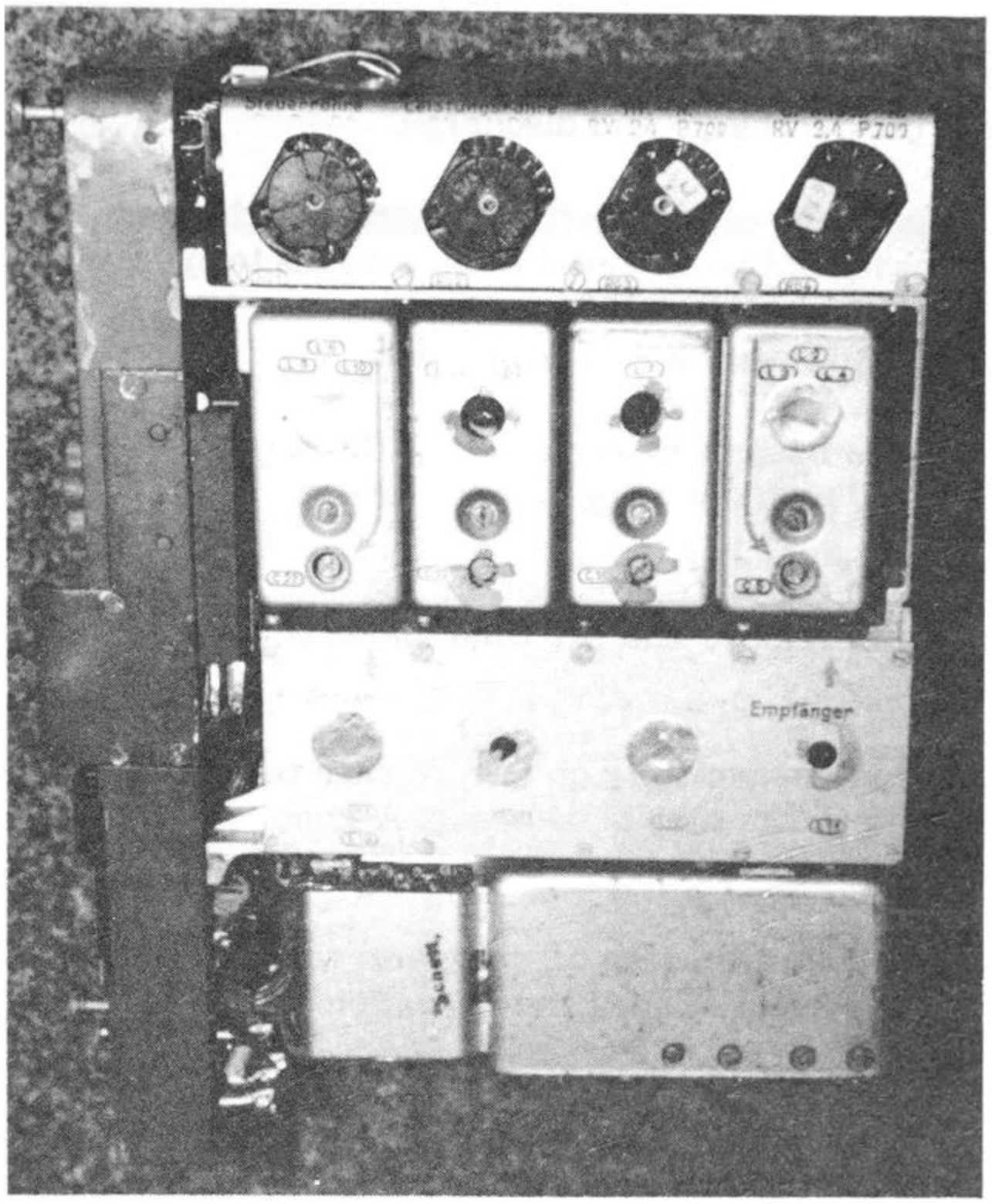


Figure 7.9 *The Torn. Fu.g removed from its case.*

4. Calibration should be made at exactly 3,500 kilocycles as indicated by a blue mark on the dial. Frequency Meter Set SCR-211 should be set to 500 kilocycles and used as the source of the calibrating signal.
5. Set the main switch to *Tg.* and adjust the receiver calibration trimmer for zero beat.
6. For an additional check, turn the dial to 3,000 kilocycles and then to 2,500 kilocycles. Zero beat should occur at both of these points and should fall within the blue mark at 2,500 kilocycles.

B. Transmitter.

1. To calibrate the transmitter, set it up as described in A1, A2, and A4 above.
2. Set the main switch to *Tg.* and close the key.
3. Adjust the transmitter calibration trimmer for zero beat (see Figure 7.9).
4. Check as in A6 above.

VI. REGENERATION ADJUSTMENT. Whenever the detector tube is changed, it may be necessary to adjust the regeneration control of the receiver. Aging of the tube may also make it necessary to adjust the regeneration.

A. Operate the set out of the case (V A1 and V A2 above) with the main switch on *Tn.*

B. Carefully turn the regeneration control screw to the right or left until regeneration starts.

VII. BATTERY CHARGING. Charging requirements of nickel-iron-alkali storage batteries are different from the more common lead-acid type. The following instructions should be observed:

A. Remove the two metal filler plugs before charging and check the electrolyte level. If the plates are not covered, add enough distilled water to cover them.

B. Charge the battery ten hours at a 4.2-ampere rate or seven hours at a 6-ampere rate. The higher charging rate is preferable. The charge is complete when the voltage at the battery terminals measures 3.6 volts and remains at this value for two hours with the charger connected and delivering 6 amperes.

C. After the battery is charged, clean the filler plugs and replace them. Clean the top of the battery and the terminals. Then go over the entire battery with a lintless, oily cloth.

D. The battery will give better service if it is short circuited and completely discharged just before charging. A hydrometer cannot be used to check the electrolyte level since its specific gravity remains practically constant during charge and discharge.

VIII. MAINTENANCE. Detailed maintenance instructions are not included in this chapter. The following checks and operating precautions should be observed if the set fails to operate:

A. Check all cords, plugs, and switches to make sure they are in good order.

B. If the filament voltage is too low, charge the battery or replace it with one that is fully charged.

C. If the plate voltage is too low when the filament voltage is normal, change the vibrator. Loosen the red-ringed retaining screws and remove the set from the case to reach the vibrator.

D. If sidetone is not present in the headset when transmitting on CW, replace the a-f amplifier tube. The receiver also will be inoperative if this tube is defective. A knob for removing the tubes is attached to the back of the set.

E. If sidetone is not present in the headset when transmitting on voice and with the antenna tuned, replace the detector and a-f amplifier tubes. Check the operation of the set after replacing each tube.

F. If no antenna current is indicated by the meter when either the microphone switch or the key is closed, replace the master oscillator and the power amplifier tubes (see Figure 7.9). Check the operation of the set after replacing each tube.

G. When the antenna has been tuned for transmission, the receiver background noise should increase when the *Lautstärke* control is turned to the right. If the noise does not increase, replace the a-f amplifier, converter, i-f amplifier, detector, and a-f amplifier tubes in that order.

NOTE: Always make a calibration check after the master oscillator and the converter tubes have been replaced.

CHAPTER 8

The Feldfernschreiber

I. GENERAL DATA

A. The Field-Tele-Typewriter (FTT) is used for transmitting messages between two FTTs connected with cables.

B. Its easy installment, handling, and maintenance make it perfect for field use.

C. All teleprinter operations will be based on teleprinter manual II DV 421/3c.

D. Each FTT incorporates a sender unit and a receiver unit. The sender is activated by typing. The receiver writes the messages on a paper roll. The sender also has a printout of the message for control.

E. To operate, it needs a 12-volt battery or, where alternating current electricity is accessible, it will be connected by the rectifier for use in the FTT.

F. The cables have to be telephone wires.

G. The FTT cannot be operated on teleprinter lines that are conducted through teletype exchanges and on lines that are operated with AC telegraphy or subaudio telegraphy.

H. The reach of the FTT depends on the damp out of the lines up to about 0.5 NEPER. Usage is still possible on lines on which normal telephoning is not possible.

I. Speed of transmission: 150 signals per minute.

J. The FTT always works in conjunction with a field telephone.

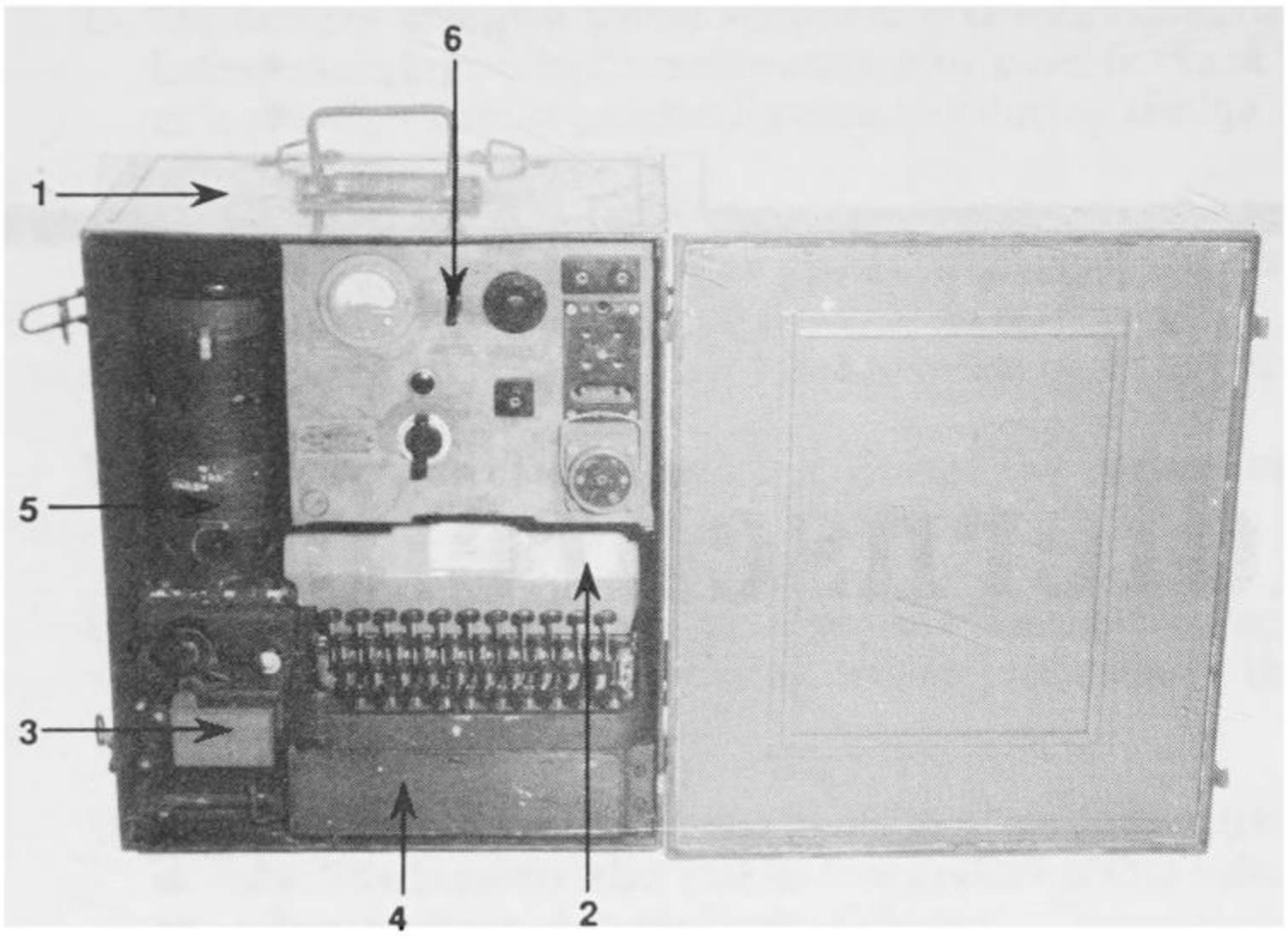


Figure 8.1 *The Field-Tele-Typewriter showing portable box (1), sender unit (2), receiver unit (3), base unit (4), motorgenerator (5), amplifier + connector set (6), cable to connect to battery (not shown).*

K. Each FTT comes complete with a portable box that holds accessories and tools.

II. DESCRIPTION OF MAIN PARTS

A. Portable Box.

1. The box is watertight, with carrier handle and backstraps.
2. On the inside of the removable lid are the instructions for use, diagrams, and two cables: one for connection to power supply, the other to connect wireless unit for wireless transmission.

B. Sender Unit.

1. The sender unit consists of the sender, the receiver, the base unit, and the motor generator.
2. The sender transforms the symbols of the keyboard into bursts of electricity.
3. It has forty-three keys (see Figure 8.2). Most are self-explanatory.

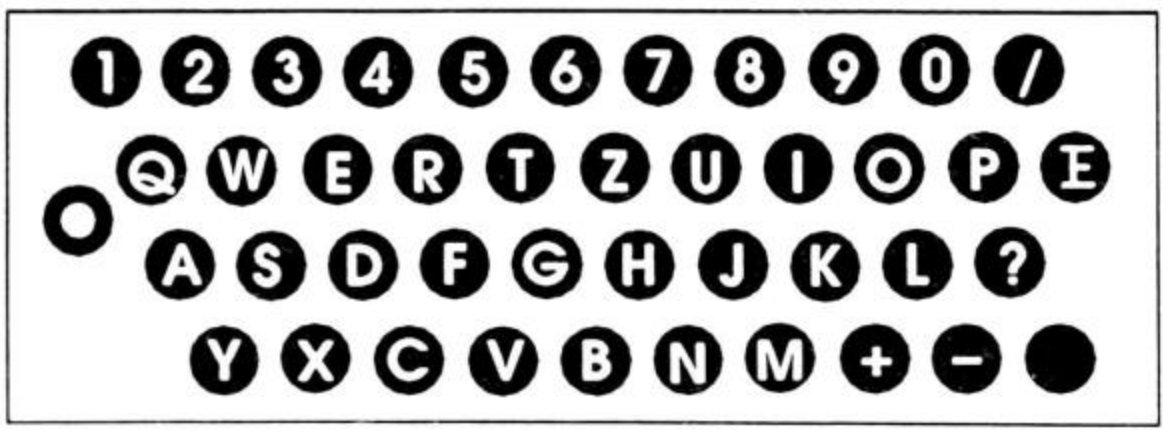


Figure 8.2 *The sender keyboard.*

● = space (lower right)
E = break interval (upper right)
O = key for Morse code (left)

4. The E is used when aligning the FTT with the apparatus on the other end and to keep contact during a break in transmission. The E key stays depressed and sends automatically until any other key is depressed.
5. The Morse key (located at the left end of the keyboard and identified by a green mark) is to be used when normal transmission is interrupted. Morse code has to be sent at a slow transmitting speed.
6. Each impulse needs 0.4 seconds for sending. All keys lock automatically for this length of time. Sending *has to* be done at a given rhythm of 2 1/2 keys per second or exactly half that speed.
7. Behind the keyboard is the contact roll, which is driven by the motorgenerator.

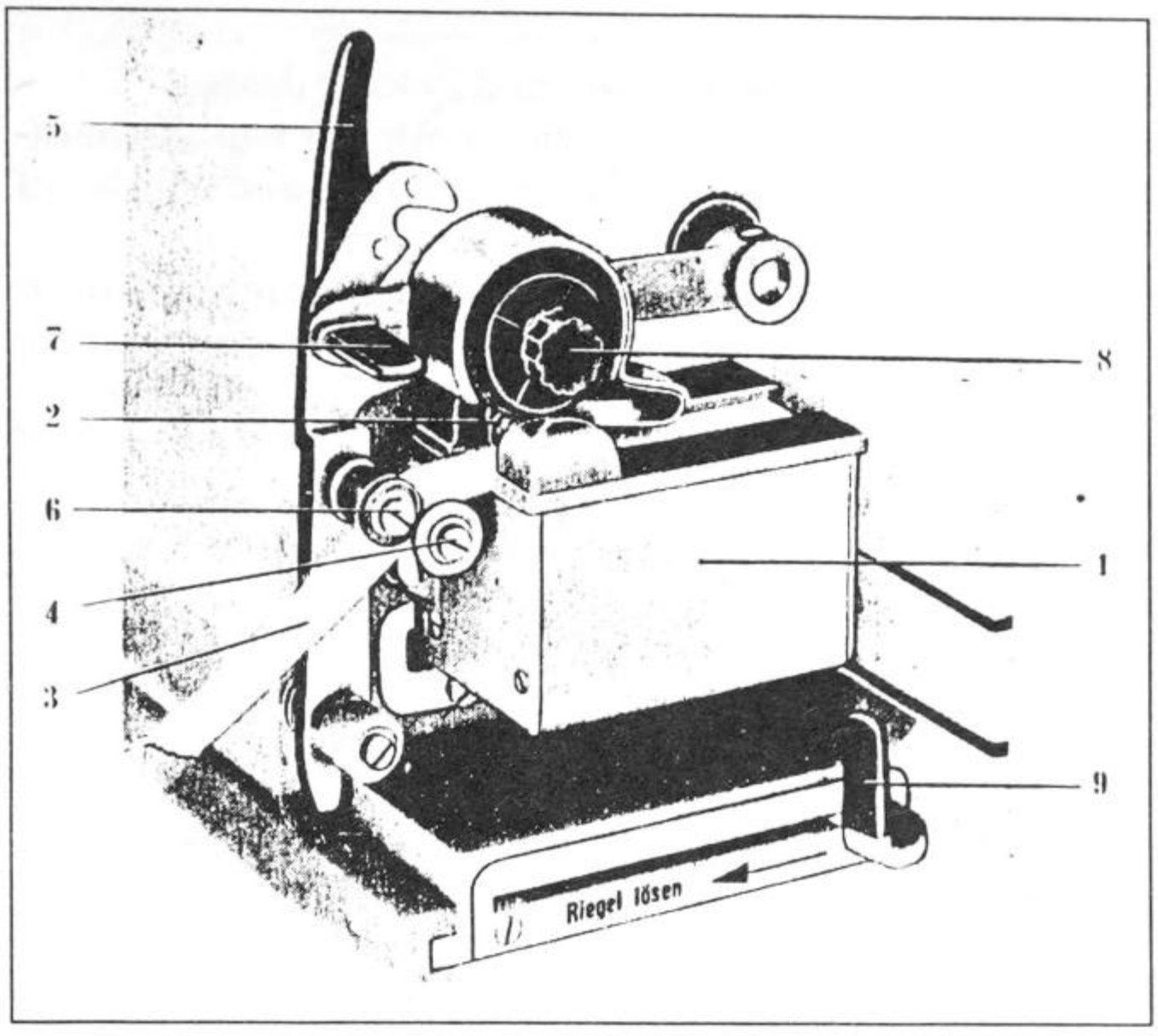


Figure 8.3 *The receiver showing the receiver casing (1), writing spindle (2), paper (3), paper feed roll (4),contact-roll lever (5), contact roll (6), ink-roll lever (7), ink roll (8), locking lever (9).*

C. Receiver Unit.

1. The arriving burst of electric pulses from the distant station are amplified and then turned into writing. During sending, the receiver also works to produce control strips of the message.

2. The burst of electric pulses is converted into written lines by an electromagnet, which drives an anchor. The latter activates a rotor, which responds in correspondence with the cycle of the electric pulses. The cutting edge attached to the rotor presses the paper against the spindle, which prints the symbols on the paper.

3. The strip of paper is slowly pulled forward by the paper-feed roll. It keeps running even during breaks in receiving.

4. The lever at the base moves the contact roll so it presses the paper firmly to the paper-feed roll. The ink roll, moved by the ink-roll lever, touches lightly on the spindle and thereby transfers ink to the spindle. To change the paper or exchange the ink roll, move the lever to the left and slightly lift the ink-roll lever to interrupt the paper feed.

5. The construction of the spindle results in a double line of writing, which makes alignment easier.

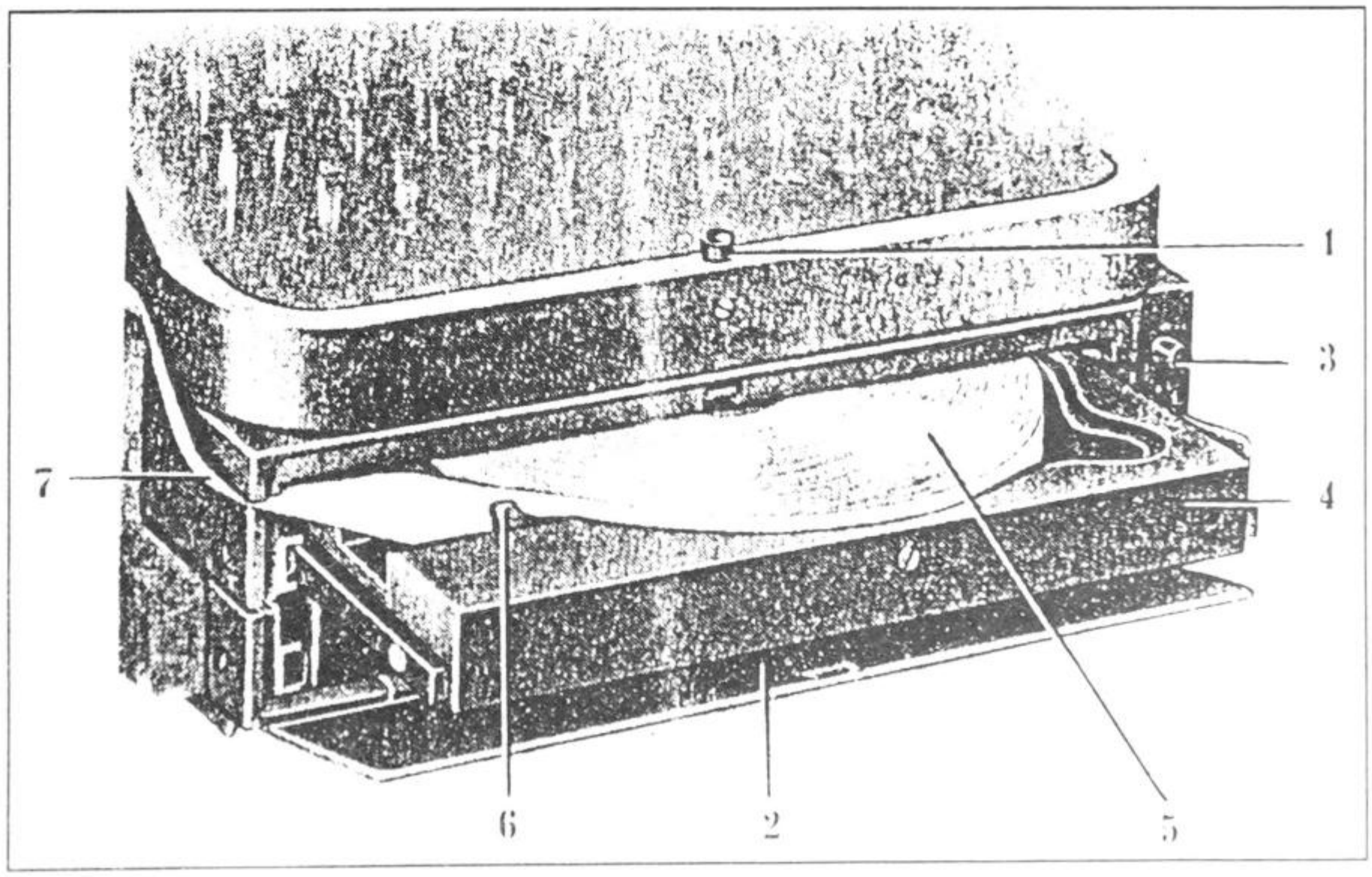


Figure 8.4 *The paper case open showing the release button (1), hinged lid (2), upper rest button (3), upper paper case (4), paper roll (5), guider (6), guiding slot (7).*

D. Base Unit.

1. The base unit contains the transmission housing, paper case, and locking device.
2. The transmission housing is situated behind the receiver underneath the motorgenerator. It houses the transmission gears for the sender, spindle, paper-feed roll, and shutter of the break (key E).
3. There are two cases for paper underneath the sender. Pressing the release button releases the lid. Then press the button on the right side and the paper case is removable (see Figure 8.4).
4. The paper unrolls clockwise with the self-sticking side facing downward. Each roll of paper is about 250 meters long. The FTT uses about 28 meters per hour.
5. To start the FTT, press the locking lever to the left, pull the apparatus forward by about 1 centimeter, and release the lever. Then pull the apparatus farther forward, which enables the keyboard to be used with ease and the paper to run freely.
6. To completely remove the FTT from the box, press the lever to the left, and remove the apparatus at the same time.

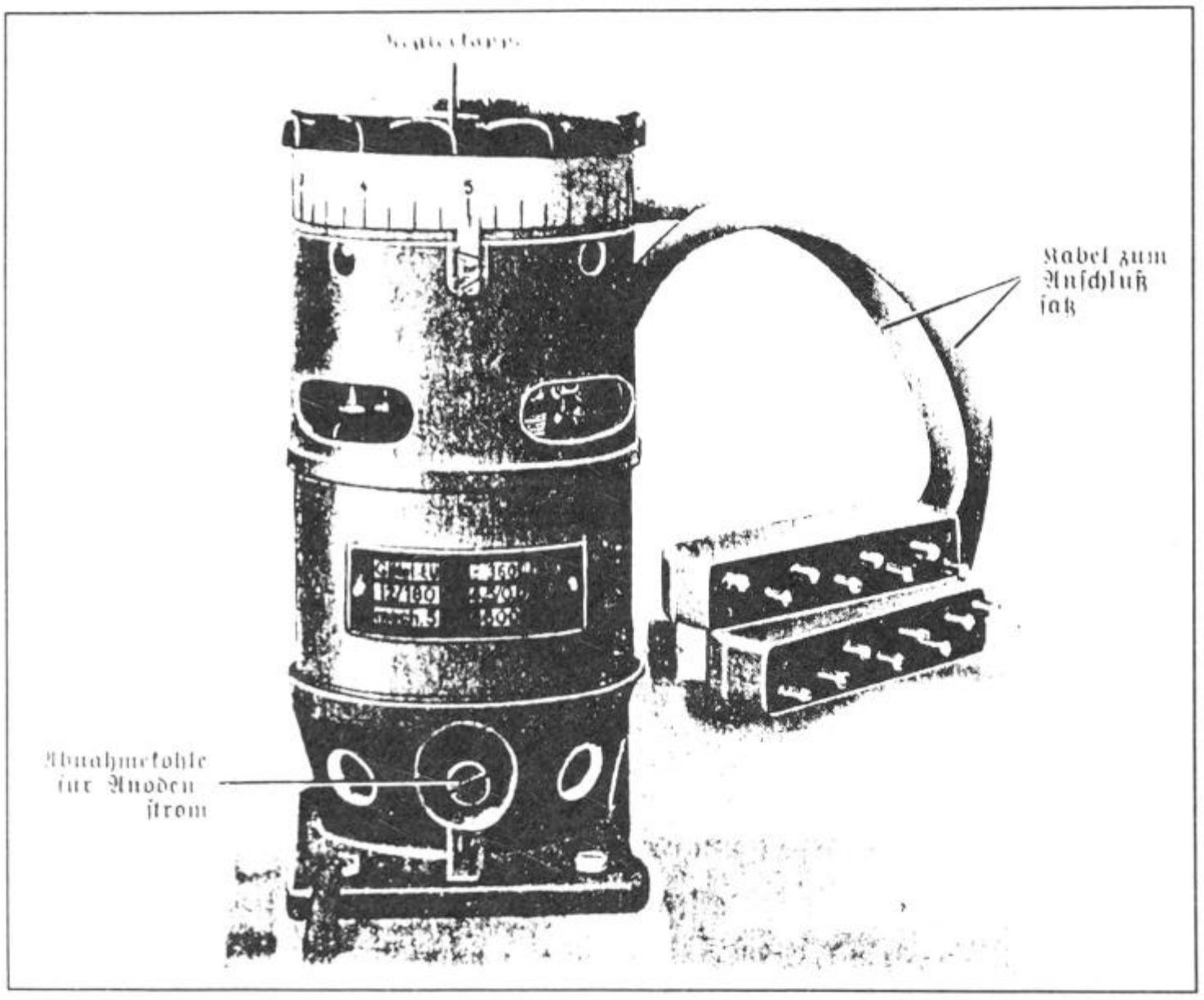


Figure 8.5 *The motorgenerator.*

E. Motorgenerator.

1. The motorgenerator drives the FTT and provides the anode electricity for the amplifier and connector unit. The carbons for transmitting the electricity to the motor winding are in the upper part of the casing.
2. A clutch connects the shaft of the generator with the gear in the lower part.
3. The anchor of the generator carries the motor winding and the generator winding, which produces 165 volts and a maximum of 15 milliamperes of electricity. The carbons for transmitting the anode electricity are at the bottom front and back (see Figure 8.5).
4. To get level writing, the motor has to have a regular speed of rotation that is the same as the speed of the receiving FTT. To keep a constant speed the motor has a centrifugal-force regulator attached, which produces an even rotation in the amplifier unit. To set the centrifugal-force regulator to correspond with the receiving FTT, twist the regulator cap on top of the generator accordingly. Twist to the left to speed up rotations; twist to the right to slow down rotations.

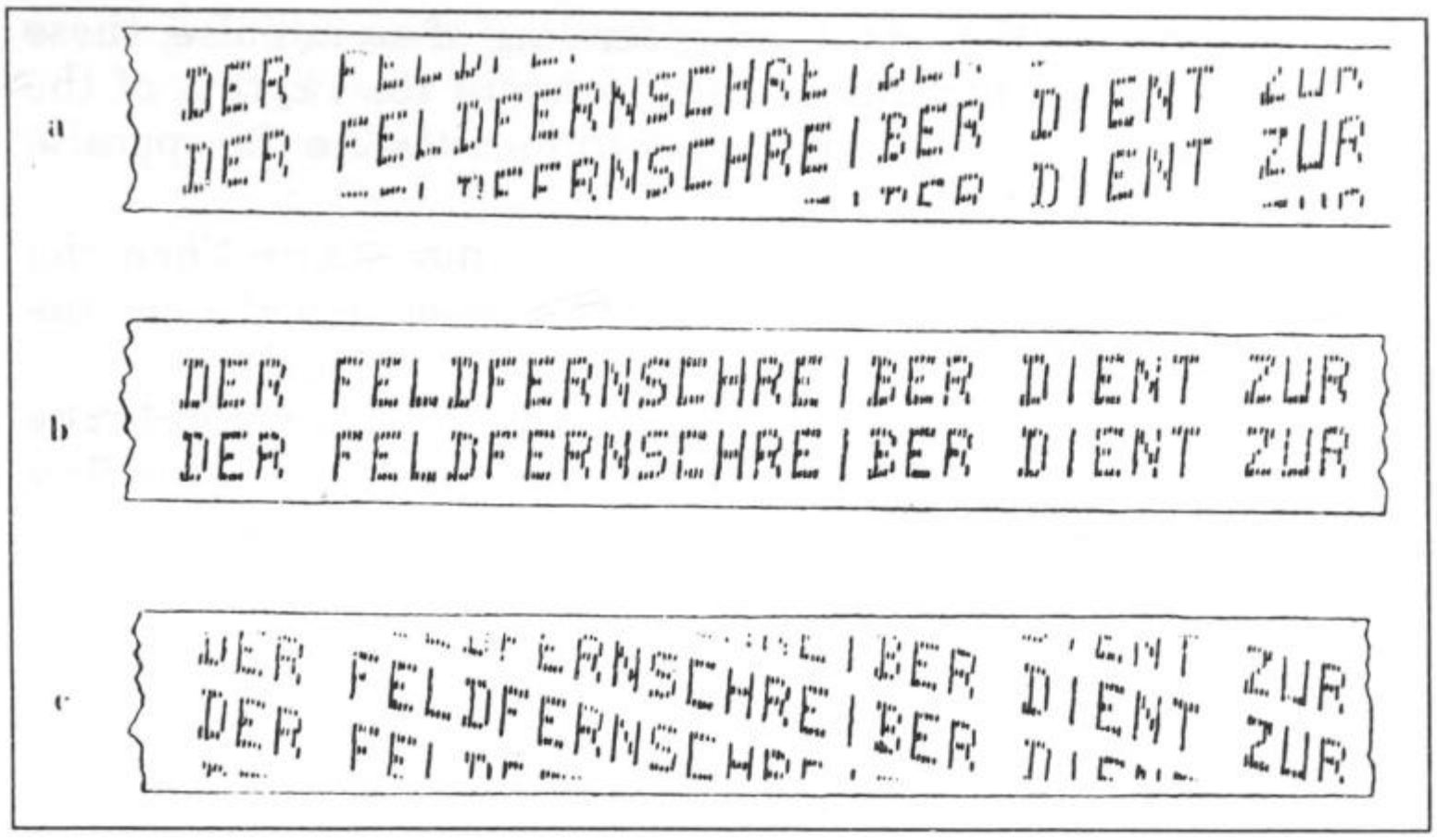


Figure 8.6 *Examples of receiving tape: generator turns too fast (a), generator turns correctly (b), generator turns too slow (c).*

5. Diversions from the correct number of revolutions are only noticeable at the receiving FTT and have to be adjusted there.
6. At the base of the motorgenerator are two cables that connect the sender and the receiver with the amplifier. Plugs are marked: red - front; green - back.

F. Amplifier and Connector Set.

1. The A + C set houses the sound generator, receiver amplifier, regulator tube, and the connections for cables, telephone, wireless, and power.

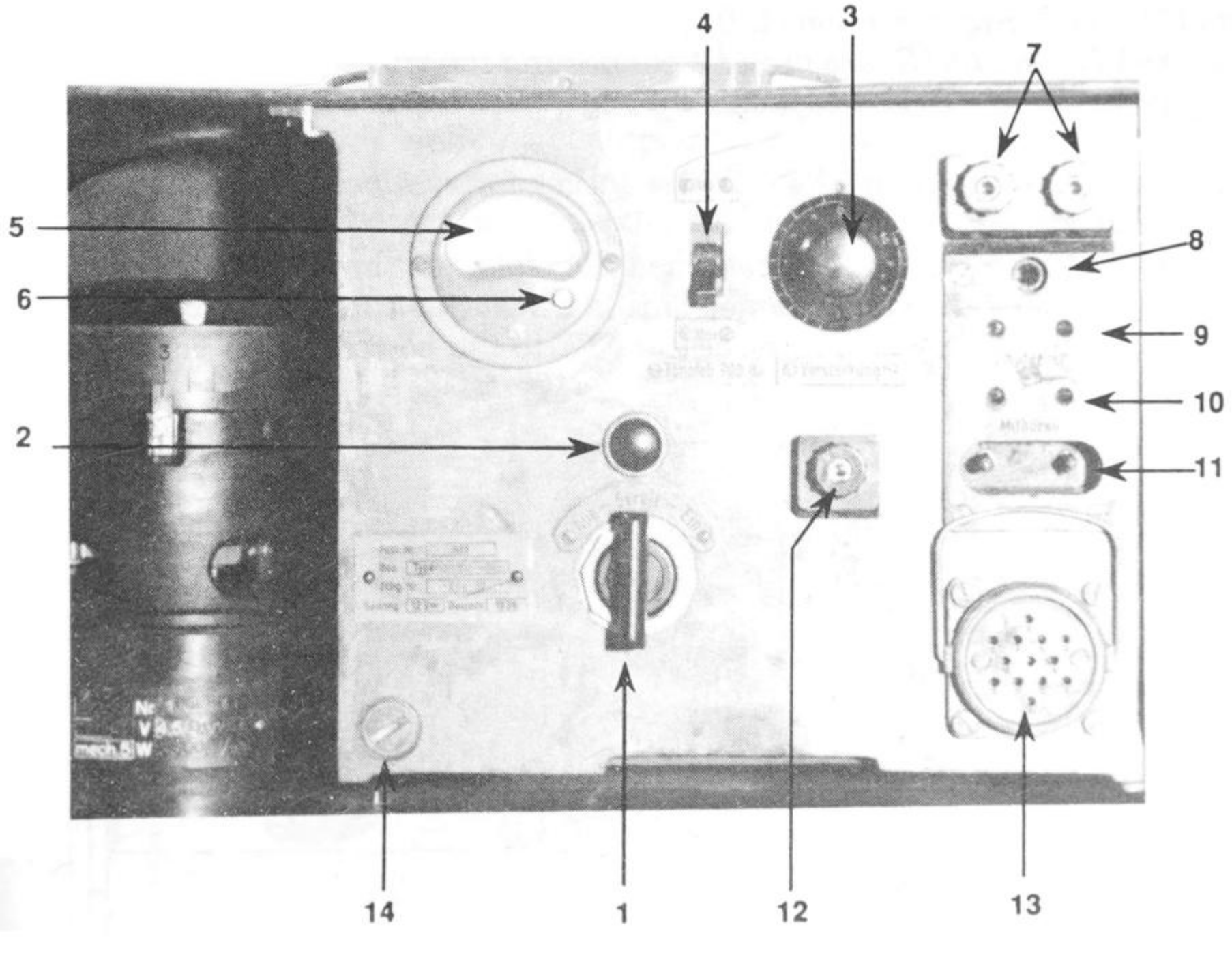


Figure 8.7 *Front view of the amplifier and connector set showing the main switch (1), signal light (2), amplifier regulator (3), sound filter 900 (4), voltmeter (5), button for anode current (6), connection to other FTT (7), connecting point for field telephone (8), receiver sockets (9), listener sockets (10), connection point to power supply (11), clip for earthing wire (12), twelve-pin socket (13), screw (14).*

2. The sound generator produces waves of 900 hertz. During sending of an impulse, these waves are being tapped out through the contact roll of the sender in the rhythm of the impulse of the appropriate key. The tapped sound frequency is transmitted to the opposite FTT and to the amplifier.
3. In the amplifier, the sound frequency is strengthened in the input stage. Then the impulses are removed in two dry rectifiers. The direct current impulses gained steer the tube in the end stage, the anode current of which moves the magnet in the receiver.
4. The regulator tube keeps the number of rotations of the motorgenerator constant. The contacts within the motorgenerator, activated by the centrifugal regulator, control the flow of the anode current to speed up and slow down the motor.
5. Description of A + C Parts.

a) The main switch can be set to one of three positions: *Aus* switches the unit off; *Bereit* (ready) heats up the tubes and lights up the signal light; *Ein* starts the motor and switches off the light. The main switch has to stay on *Bereit* for a full minute before turned to *Ein* or the tubes may be damaged.

b) The red signal light shows that the FTT is connected to the power supply. Remove the red cover plate to exchange the bulb.

c) The amplifier regulator moves a potentiometer, which lowers the electricity on entry to amplifier if necessary. Set at 10, where the amplifying is most efficient. Possible interferences can be greatly suppressed. The amplifier regulator has to be turned down to a minimum setting for monitoring on the receiver.

d) If the sound filter 400 is set to *Mit* (with), it suppresses interference but leaves the monitoring frequency at 900 hertz. Use only if a lot of interference is picked up during receiving.

e) The voltmeter is used to check battery voltage and anode voltage if set to *Bereit* or *Ein*. It measures the voltage of the 12-volt battery. Any diversion (11 to 13 volts) is shown on the red dial. If set to *Ein* and the blue button is pressed, it shows the anode voltage of the motorgenerator (165 volts). Any diversion (150 to 190 volts) is shown on the blue dial.

f) The sockets, marked *La* and *Lb/E*, are used for connecting the wires to the FTT.

g) The connecting point for the field-telephone wire lies between the sockets marked *La* and *Lb/E*.

h) The *Empfanger* sockets connect the FTT to the socket for receiver headphones by cable during wireless transmission.

i) The *Mithoren* (listen) sockets are used to connect headphones that are used when using the Morse code key or when using telephones until a better line can be obtained.

j) The double socket (+ volt -) is used to connect the FTT to the power source via cable stored in the lid.

k) The clip for grounding connects the grounding wire.

l) The 12-pin socket is used to connect the transmitter set. The necessary equipment is not yet in use, so the 12-pin socket has no function at present.

m) The screw is used to attach the A + C set to the portable box.
6. If the amplifier unit is removed from box 6, more sockets are visible into which the corresponding contact plugs should be set.

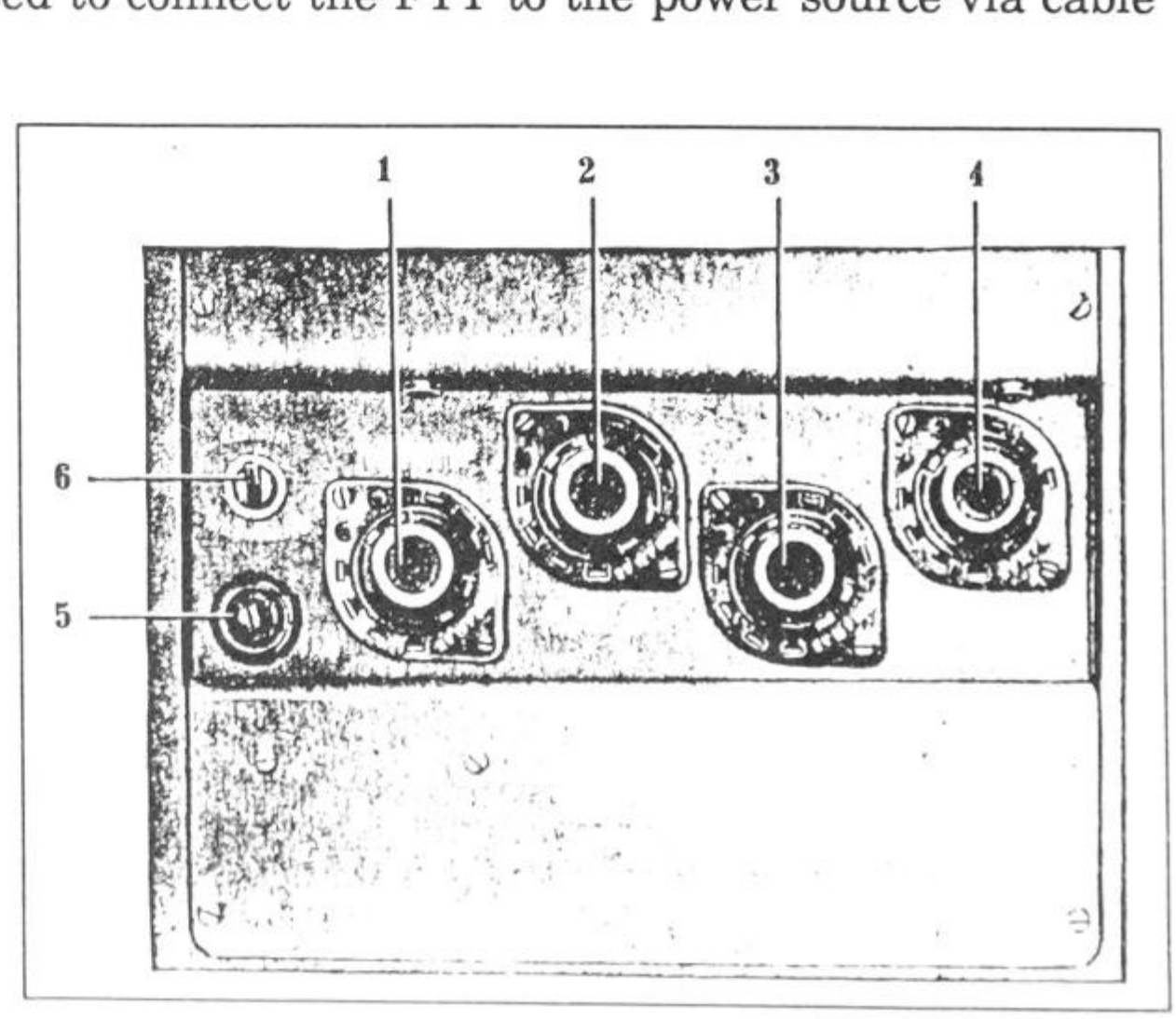


***Figure** 8.8 The cover plate for the amplifier and connector set.*

7. The cover plate of the A + C unit (Figure 8.8) houses the following:

a) Four tubes (labeled 1, 2, 3, and 4 in Figure 8.8), all model RV12P4000, one each for the sound, regulator, input stage, and end stage.

b) One 6-amp fuse with switch marked *Sammler - Netzgleichnichter* (accumulation - power rectifier). Always leave the switch on *Sammler*. The *Netzgleichnichter* setting was for previous models only.

III. MODES OF OPERATION

A. Breaking Up of Symbols in the Sender.

1. The FTT does not print the symbols like a typewriter but breaks them up into longer and shorter lines. This makes for less interference than a telegraph unit and therefore it is better for field usage. Electrical interference can make a telegraph unit send wrong symbols, whereas the FTT might just have a slightly fuzzy writing.

2. Letters and numbers are broken up according to the seven-line writing. Five vertical lines are used for the symbol. One line on either side provides spacing between symbols. Each line is divided into longer and shorter dashes according to the letter or number. These dashes must be no smaller than 1/7th of the whole length. (Figure 8.9 shows an example of an easy symbol, E, and a more complicated one, number 6.)

3. The symbol is transferred to a contact ring. All vertical lines are transferred from bottom to top, left to right. (See Figure 8.10 for contacting of the letter E. On the ring, the black bits are insulated, therefore causing pauses; the white bits are metal, therefore conducting electricity.)

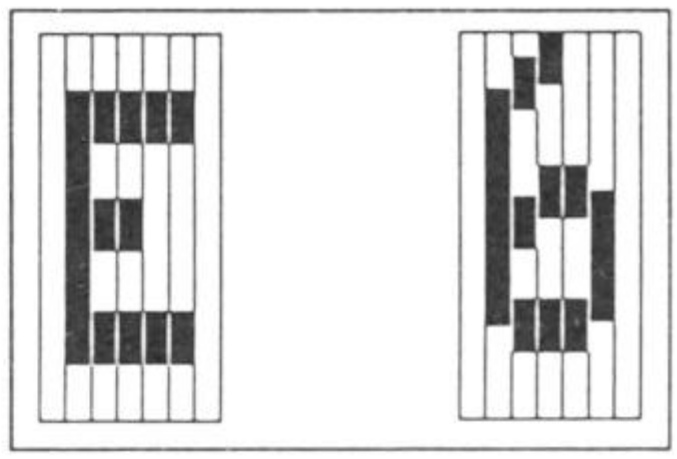


Figure 8.9 *Analysis of the letter E and number 6.*

4. Each key has its own contacting (see Figure 8.11). The metal segments are joined to make up the contact roll. In front of each roll is a sliding contact. By pressing down on a key, the connecting piece pulls down the locking lever and releases the sliding contact from the notch. The spring now pulls the sliding contact onto the contact roll. Now it sends the appropriate bursts of electricity down the line according to the ring. The key-locking device is controlled by the cam via

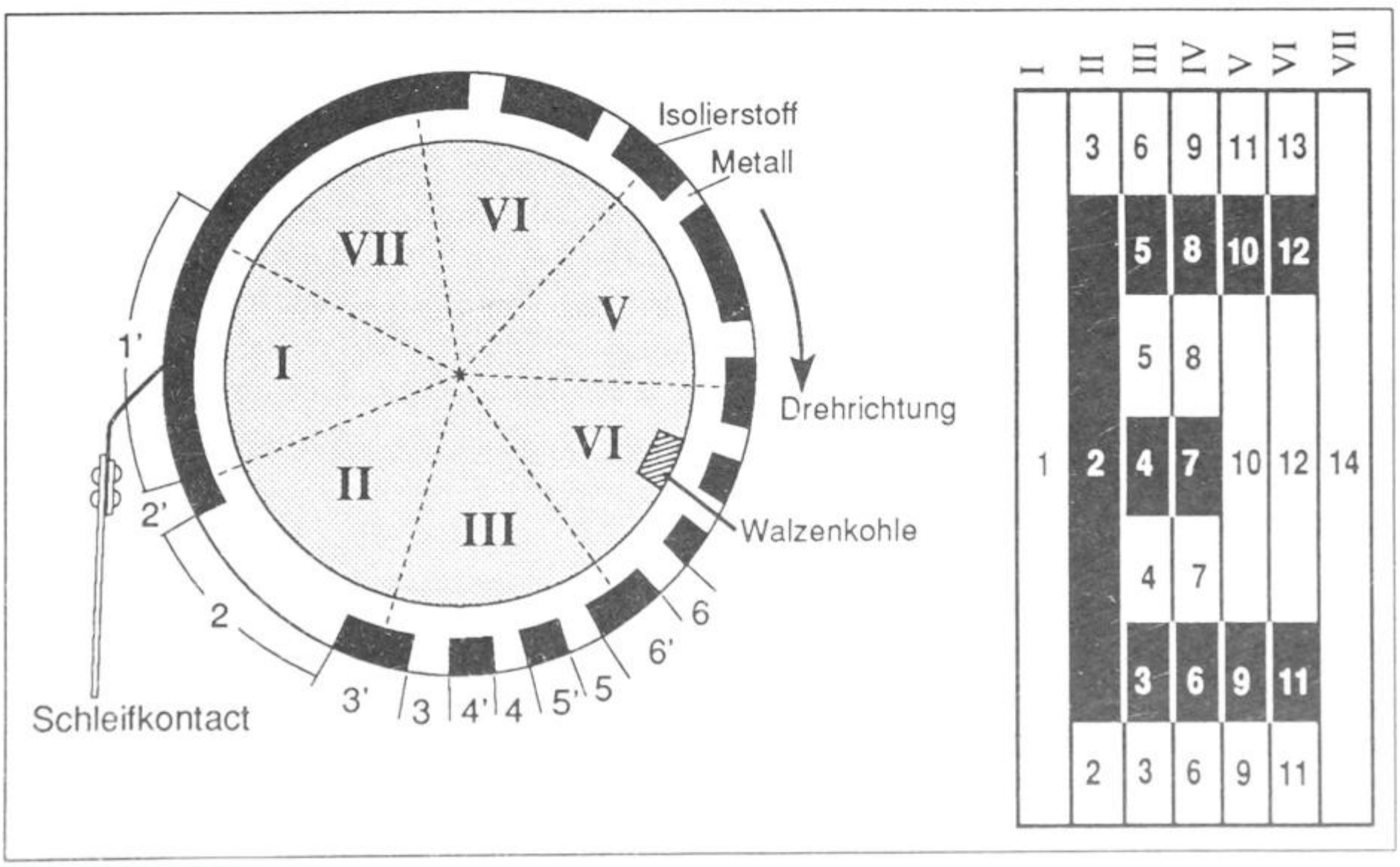


Figure 8.10 *Contact ring for letter E.*

the transfer lever to ensure that contact of each key starts at exactly the right spot on the roll. After the process is finished, the locking device pushes the sliding contact back into its notch and allows another key to be pressed.

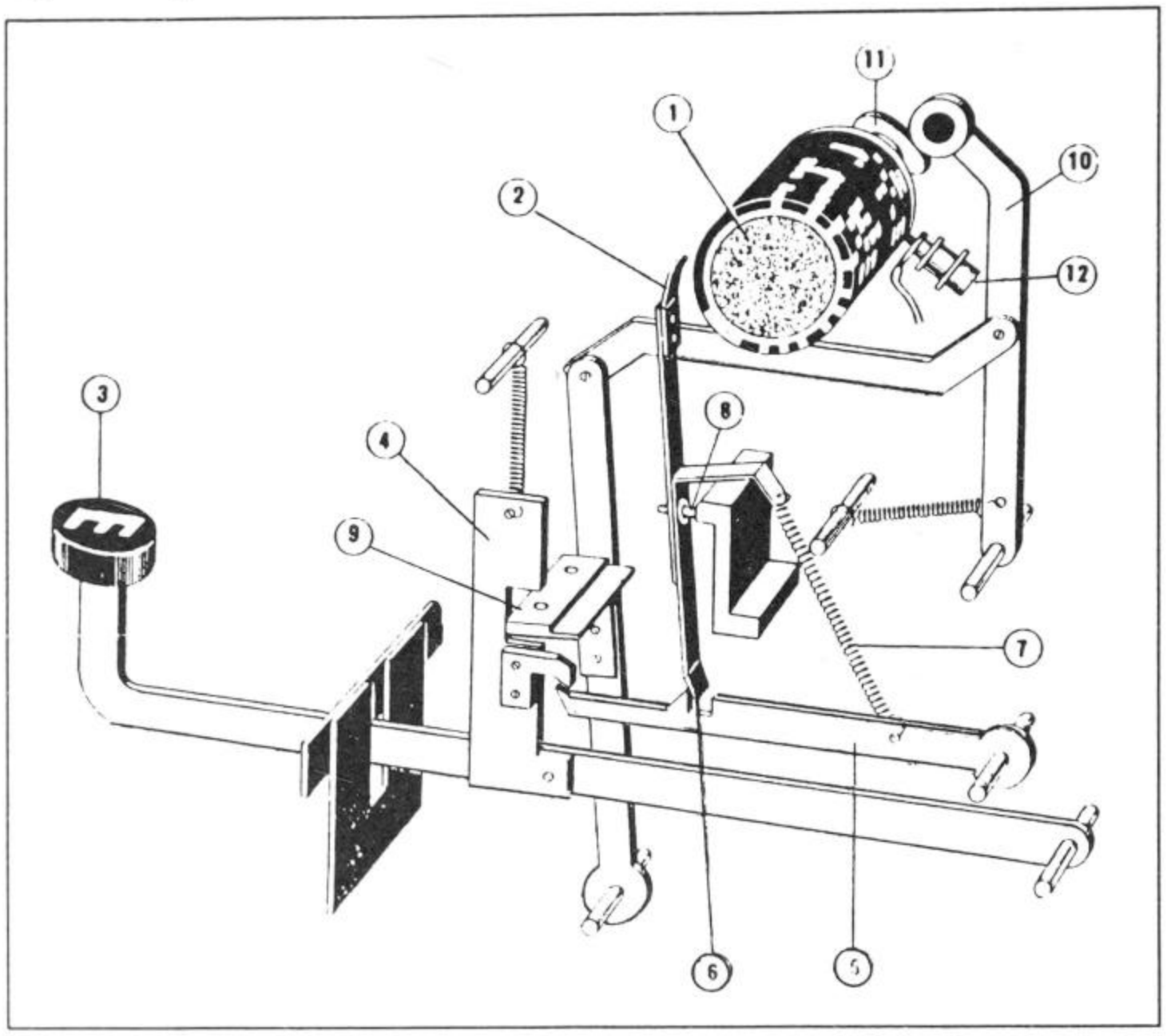


Figure 8.11 *The FTT sender showing the contact roll (1), sliding contact (2), key (3), connecting piece (4), locking lever (5), notch for sliding contact (6), spring (7), pivot for sliding contact (8), key locking device (9), transfer lever (10), cam (11), roll carbon (12).*

5. If key E is pressed, its sliding contact is activated, but it stays in the depressed position and sends break signals until any other key is pressed. In addition, there is a resting contact underneath the key lever of the break key E that opens when the key is depressed. Therefore, the circuit is interrupted and runs via the break key shutter in the gear box. This shutter consists of a slowly turning camshaft, which makes contact only every third rotation. Therefore, only every first, fourth, and seventh signals, for example, get sent.
6. The space key has neither a contact ring nor a sliding contact, so no signal is sent.
7. The Morse code key has no contact ring and no sliding contact. Underneath the key is a working contact that closes when the key is depressed. Sending Morse code signals is totally independent from the position of the contact roll.
8. All sliding contacts lay electrically parallel. The contact rings are connected by the roll. The roll carbon is situated on a closed ring at the end. If any key is depressed, the circuit is closed and the impulses are sent in the rhythm of the activated contact ring.
9. The contact roll rotates, driven by the motor, at a constant speed of 2 1/2 turns per second. The writing speed is therefore 2.5 signals, or 7 x 2.5 = 17.5 lines per second. Each line needs 1/17.5 (0.0572) second, or 57.2 milliseconds, to run. As each electrical pulse and each break are at least 1/7 of a line long, the shortest electrical pulse or break is, therefore, 57.2 x 1/7 = 8.18 milliseconds. Therefore, the maximum short frequency is 61.25 hertz.

B. Putting the Signals Together inside the Receiver.

1. The received electrical impulses are amplified and then sent to the magnet of the receiver. The anchor of the magnet system presses the paper via a contact edge in the rhythm of the incoming bursts of electricity against the writing spindle. The anchor spring pulls down the anchors as far as the contact pin and thereby releases the pressure during the break of electricity. The paper is slowly fed through the contact edge and the

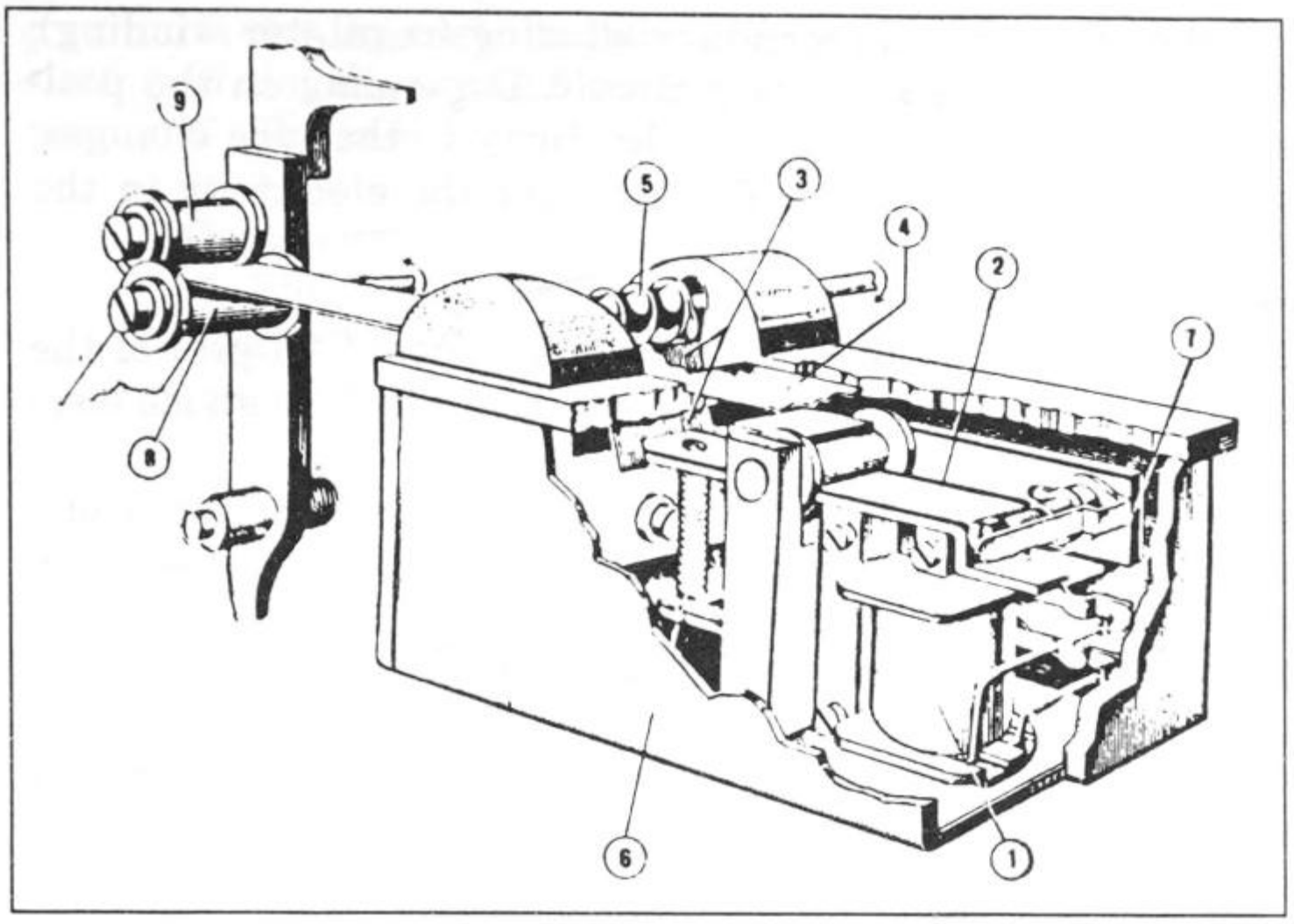


Figure 8.12 *The FTT receiver showing the magnet (1), anchor (2), contact edge (3), paper (4), writing spindle (5), anchor spring (6), contact pin (7), paper-feed roll (8), contact roll (9).*

writing spindle by the paper-feed roll and the contact roll. The writing spindle, driven by the motor, turns at a constant speed and is inked by the ink roll.

2. The writing spindle has two threads. These touch the paper on one point each. If the spindle moves, these points run lateral to the paper so that each half-turn of the spindle produces two lines next to each other. In line with the turning of the spindle, the paper moves forward one width of a line of a symbol.

3. The next line sits beside the line already printed when contact is reestablished through the contact edge. After seven lines, the whole symbol is transmitted and appears twice on the paper (see Figure 8.6).

C. Regulating the Speed of Rotations of the Motorgenerator.

1. To get even writing, the speed of the rotation has to be constant. This is achieved by the centrifugal-force regulator (situated in the upper part of the motor) in conjunction with the regulator in the amplifier unit.

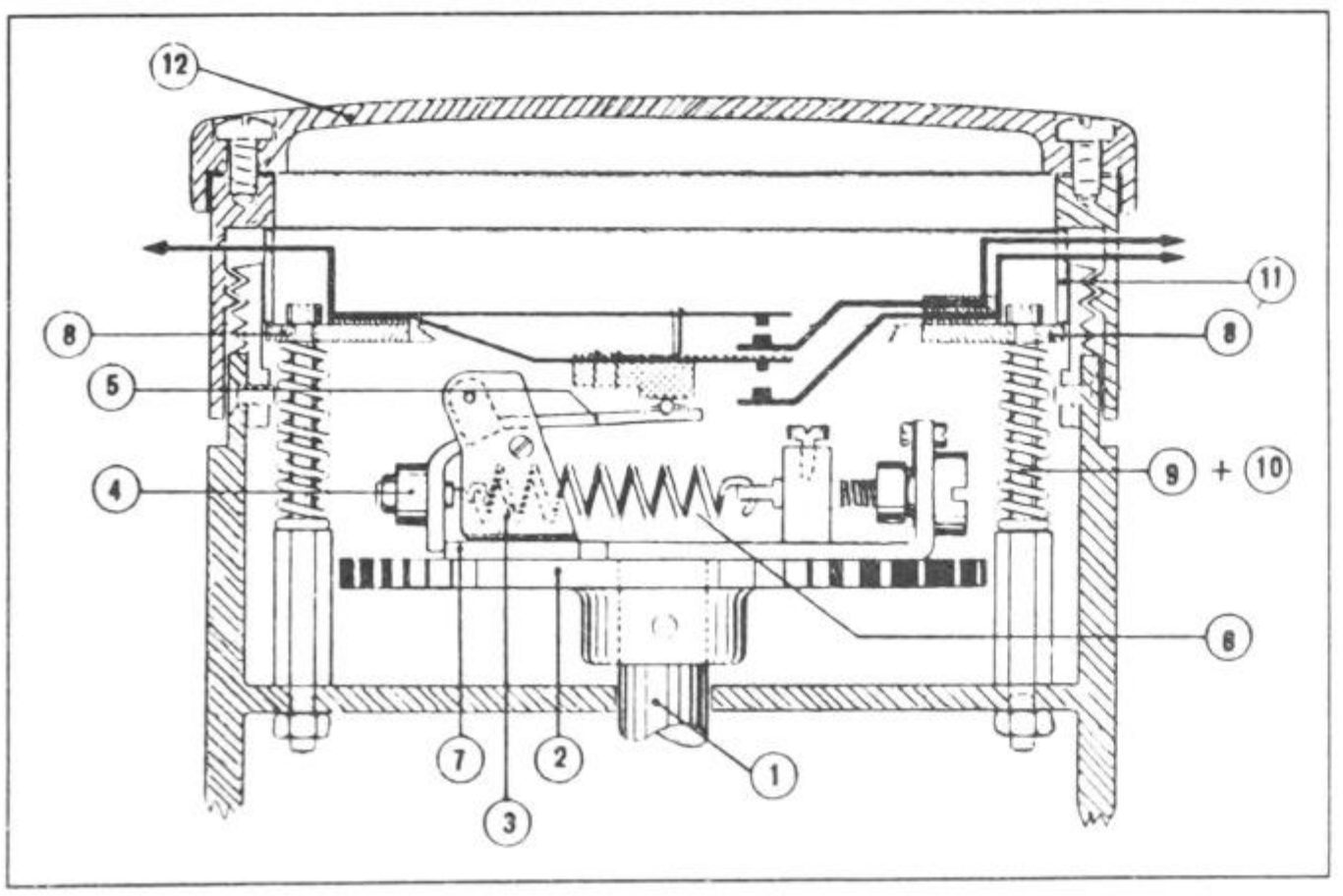


Figure 8.13 *The centrifugal-force regulator of the motorgenerator showing the motor axle (1), metal plate (2), guide holder (3), centrifugal weight (4), lever (5), spring (6), stopper (7), contact plate (8), pin (9), spring (10), ring (11), regulator (12).*

2. The motor axle supports a metal plate; the guide holder is mounted on this. Inside this lies the centrifugal weight connected to the lever. The spring pulls the weight inward as far as the stopper, and the end of the lever upward. When the motor axle turns, the weight pushes outward and the lever downward.

3. As well as the main winding, the motor has a secondary winding (regulator winding); the regulator tube (anode cathode) lies in this secondary circuit. Depending on the position of the contacts of the centrifugal regulator, the anode electricity in the tube changes, therefore the tube acts like a changeable resistance. The stronger the electricity in the regulator, the slower the motor turns.
4. In detail:

a) If the number of rotations is too low, both contact points are open. The grid of the regulator tube lies over the resistor; therefore a negative voltage develops. The anode electricity and the field are weak, and the number of rotations increases.

b) If the number of rotations is average, the upper contact is closed and the lower one open. The grid receives no extra voltage; therefore, the anode electricity increases, the field strengthens, and the number of rotations stays the same.

c) If the number of rotations is too high, both contacts are closed; the anode tube and grid are short-circuited. The field strengthens and the number of rotations falls.

5. The contact plates (see Figures 8.8 and 8.13) are held by two pins and guided upward by the springs until they press against the rings, which are pressed down when the regulator cap is tightened. Through loosening and tightening of the regulator cap, the contact plates are moved up and down. If the cap is loosened, the contact plates close by a low number of rotations; if the cap is tightened, the number of rotations increases.

D. Electric Circuit of the A + C Set.

1. See II F for a description of the unit.
2. The sound *Sammler* (storage battery) is a tubular *Sammler* RO 16 with three settings, which is fixed to a frequency of 900 hertz. The transmitter SU transmits the sound frequency to the sender circuit. The tapped frequency is transported via the line transmitter LU to the sockets *La* and *Lb/E* and to the receiver amplifier.
3. On entry, the sound frequency symbols are fed via the connectors *La* and *Lb/E* and the line transmitter LU to the receiver. The potentiometer W24, which lies parallel to the sockets for wireless transmission, regulates the level of incoming voltage for the amplifier.
4. The sound filter 900 consists of a switch U28 which, when set to *Ohne* (without), bridges the resistance W25. The sound frequency is fed to the oscillator circuit C28.EU, which is set to 900 hertz. For the frequency of 900 hertz, this circuit represents a high alternating current resistor. But for interfering frequencies above or below 900 hertz, it is only a low resistor.
5. The sound frequency symbols reach the input state via the transmitter EU, are amplified in the tube RO 29, and are transmitted by the intertransmitter ZU to the rectifiers GL 34 and GL 35. The secondary winding of the intertransmitter also has the sockets for *Uithoren* (listen). After going through a resistor condensation arrangement the direct currents reach the end stage. These control the anode current in the tube RO 29, which moves the magnet of the writing system of the receiver.

IV. OPERATING THE FTT

A. Preparation.

1. Important: If opened, the FTT has to be protected from moisture, dust, and dirt.
2. Ensure the FTT is grounded before use.

B. Making the FTT Ready.

1. Open by unclipping the four hinges.
2. Press the locking lever to the left and pull the sender unit forward by 1 centimeter, release the lever, and pull out the unit until the lever clicks into place.
3. Check the paper to release the case.
4. Connect the ground wire to the ground clip.

5. Set the main switch of the A + C unit to *Aus*.
6. Set the sound filter 900 switch to *Ohne*.
7. The indicator of the measuring device has to be on 0.

C. Connecting the Electricity Supply.

1. Plug the battery cable into the 12-volt socket of the A + C unit. (+ to + and - to -).
2. Fasten the other ends to the 12-volt-battery terminals or to the terminals of the rectifier, again + to + and - to -.

D. Connecting Cables and Telephones.

1. If the cable is double, fasten to both terminals *La* and *Lb/E*.
2. If the cable is single, fasten it to terminal *La* and ground *Lb/E*.
3. Connect field telephone 33 by putting its connecting cable into the A + C unit's jack.

E. To call opposite FTT, crank the handle of the field telephone. If the distance is too great for the call, start both FTTs simultaneously at a prearranged time (e.g., every hour on the hour).

F. To Operate.

1. Turn the main switch to *Bereit*. The signal light will light up, and the voltmeter must indicate voltage within the red.
2. Leave the main switch in this position for one minute to activate tube heating.
3. After this time, set the main switch to *Ein*. The signal light will go off, the motor will start running, and the voltmeter (by depressing the button) will show in the blue.

G. Sending.

1. The keys are driven by the motor, so put fingers lightly and without pressure on a key until it depresses. Let go immediately and go on to the next key.
2. If used correctly, 2 1/2 signs per second are sent or, if that is too fast, exactly half that number.

H. Receiving.

1. To start, set the *Verstarkung* (amplification) dial to get the best quality writing.
2. If the connection is very bad, set *Tonsieb 900* (sound filter 900) dial to *Mit* and reset the *Verstarkung* dial to obtain the best writing.

I. Setting of Writing.

1. Set the regulation caps of both FTTs to number 5.
2. Ask the opposite FTT to send test letters and use the regulation cap to set the writing straight.

J. Pause and End of Message.

1. For a short break, depress key E; it will automatically send until released.
2. To end transmission, set the main switch to *Aus* and use the handle to break the connection with the telephone operator (if in use).

K. Threading the Paper.

1. Loosen the end of the paper roll and place paper into the case so it unwinds in a clockwise direction. Pull the paper through the guiding slot, making sure the self-sticking side is underneath.
2. Lift the ink-roll lever to its upper position. Thread paper underneath the spindle and between the paper-feed roll and contact roll.

L. Changing the Ink Roll.

1. Twist the lever upward, hold, remove the used roll, and put in a new one.
2. Used ink rolls have to be repainted immediately with HB 45 violet ink. Paint the roll eight to ten times with a brush and let dry for four to six hours. The roll is then ready for reuse.

M. Changing the Tubes and Fuse.

1. Remove the bolt marked with a red ring and pull the amplifier unit forward. Remove the old tubes from their sockets. New tubes have to be adjusted into place. Use slight pressure.
2. To change a fuse, remove screw top and fuse. Put in a new fuse and replace screw top.

N. Labeling. Write name on the white label on the protective cap of the contact roll.

IV. DIAGNOSIS OF FAULTS

This chapter is a summary of what has already been described and therefore needs no further explanation.

V. TECHNICAL DATA OF THE FIELD-TELE-TYPEWRITER

A. General Data.

Usage: transmission of written symbols via cable or wireless

Parts: a portable box containing sender unit (sender, receiver, base, and motor-generator) and A + C unit (two cables, two rolls, and paper)

Weight: 25 kilograms

Measurements
Height: 455 millmeters
Width: 390 millimeters
Depth: 240 millimeters

Power Source: 12-volt battery, at least 40 ampere-hours for 10 hours of use, or a rectifier for FTTs

Swing in voltage: up to 13 volts permissible

B. Sender.

Speed of writing: 150 symbols per minute, or 2 1/2 symbols per second

Composition: 7 lines of writing per symbol

Telegraphy speed: 122.5 Baud

Number of rotations of contact roll: 150 rotations per minute

C. Receiver.

Current consumption: about 10 milliamperes by 165 volts

Resistance of the direct current of the writing system:
4200 ohm

Number of rotations of the writing spindle:
525 per minute

D. Base Unit.

Self-sticking paper roll
Length: 250 meters
Width: 15 to 0.1 millimeters
Thickness: 0.0065 +/- 0.005 millimeters
Diameter: 29 + 1 millimeters

Paper usage: about 28 meters per hour in use

Number of rotations of paper-feed roll: 12.5 rotations per minute

Rotations of the shutter of key E: 16.7 rotations per minute (= 1/9 of the rotation of the contact roll)

E. Motorgenerator.

Number of rotations: 3,600 rotations per minute

Performance: with 12-volt voltage and 2.5-ampere current consumption, the electrical performance is 4 watts (165 volts/25 milliamperes); the mechanical output is 4 watts

Precision of rotation: +/- 1.5 per thousand

Limit of regulation: +/- 4 by turning the regulator cap

F. Amplifier and Connector Set.

Circuit: 1 sommer for 900 hertz; 1 receiver-amplifier consisting of an input state, rectifier, and end stage; 1 regulator for the motorgenerator

Tubes: 4 tubes RV12P4000

Heater current absorption of fuses: about 0.9 amperes

Sound filter: set to *Mit* bandwidth +/- 100 hertz

VI. CARE AND MAINTENANCE

Care and maintenance are only to be done by a qualified FTT mechanic. Follow the instructions carefully.

A. Cleaning.

1. Remove dust and oil with fine brushes and cloths every four weeks or every hundred hours of use.
2. To clean the sender contact roll, take out the sender unit but do not disconnect cables. Remove the protective cap and switch on the motor. Use a little kerosene to clean the roll and contact rings. Do not oil or grease.
3. Clean commutators with a little petrol. If they are very dirty, remove the rotary converter as in C2(f) below, use fine sandpaper on commutators, and wipe clean.

B. Maintenance.

1. Oil and grease parts every hundred hours of use or every eight weeks.
2. Do not remove the regulator. Remove the cap as in C2(g) below, dip a small strip of paper in oil, remove excess oil, and insert between the round piece in the lever and the insulating piece of the lower contact spring. Pull paper through and replace the cap.
3. Motor carbons have to be renewed when smaller than 5 millimeters. See C2(q) below.
4. Generator carbons have to be renewed when smaller than 6 millimeters. See C2(r) below.
5. Roll carbons have to be renewed when smaller than 5 millimeters. See C2(s) below.
6. To set the number of revolutions of the sender, turn the regulator cap to 5, switch on the motor, and press key E. If the number of revolutions is correct (3,600 revolutions per minute), fifty symbols should be written in 89 (+/- 2) seconds. If this is not so, turn the regulator screws (turn on motor to do this).

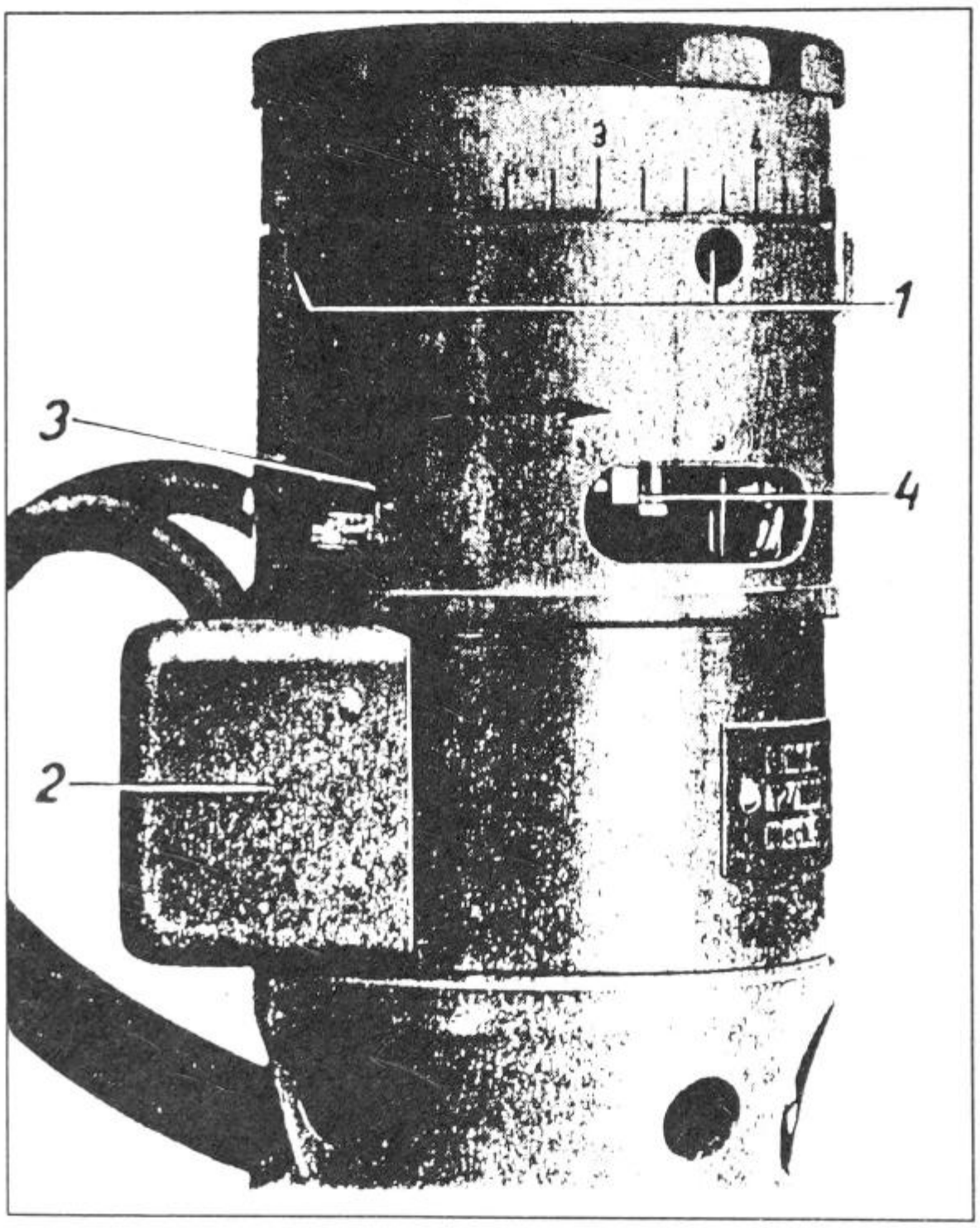


Figure 8.14 *The motorgenerator with regulator showing the regulator screws (1), protective cap (2), terminal for motor carbon wires (3), pivot for motor carbon (4).*

7. Setting the number of revolutions on the receiver motor. The writing on the sender is constant. If the writing on the receiving FTT cannot be adjusted when the number of revolutions is changed at the sending FTT, check as in B6 above.
8 Setting the writing. If the two lines of writing are not exactly underneath each other, the writing system has to be adjusted. Remove as in C2(j) below and turn the cogged wheels until the writing is aligned. Moving the spindle wheel by one cog raises writing upward by 1 millimeter. Fasten as in C22(j). Adjust key E as in C2(c).

C. Removal and Installation of Main Parts and Changing of Small Parts.

1. Amplifier and connector set.

a) Removal. Remove the bolt marked with a red ring and pull the A + C set forward. Then unplug all connections so the apparatus can be removed.

b) Installing. Connect the plugs to the sockets as follows:

(1) Plug for motor is red and marked "front."

(2) Plug for motor is green and marked "back."

(3) Fit the A + C set onto the guider rails, push set in, and secure with bolt.

c) Changing the voltmeter.

(1) Remove screws, pull forward carefully, and unsolder connection points.

(2) Solder the connection points of the new or repaired voltmeter to the cables, watch for the poling, carefully replace voltmeter, and screw into place.

d) Changing parts inside the A + C set.

(1) Remove A + C set according to 1a above, unscrew the six screws on the back, and remove back plate. Unsolder the connections to the plate (which carries the rheostat and condenser) and unscrew the screws along one length. Remove the four screws that hold the upper cover plate (which holds the tubes) and remove both plates. All parts are now accessible and can be exchanged.

(2) Reverse process for reinstalling.

2. Sender unit.

a) Removal. Press the lever to the left until it moves on its own accord further left. Now the sender can be pulled out. Both cables are to be disconnected according to 1a above.

b) Installing. Push the sender about 3 centimeters along the guider rails, press the lever to the left, and push the sender in about halfway. Now let go of the lever and push the sender in all the way. Plug the cables into the sockets according to 1b above.

c) Changing parts of the sender unit.

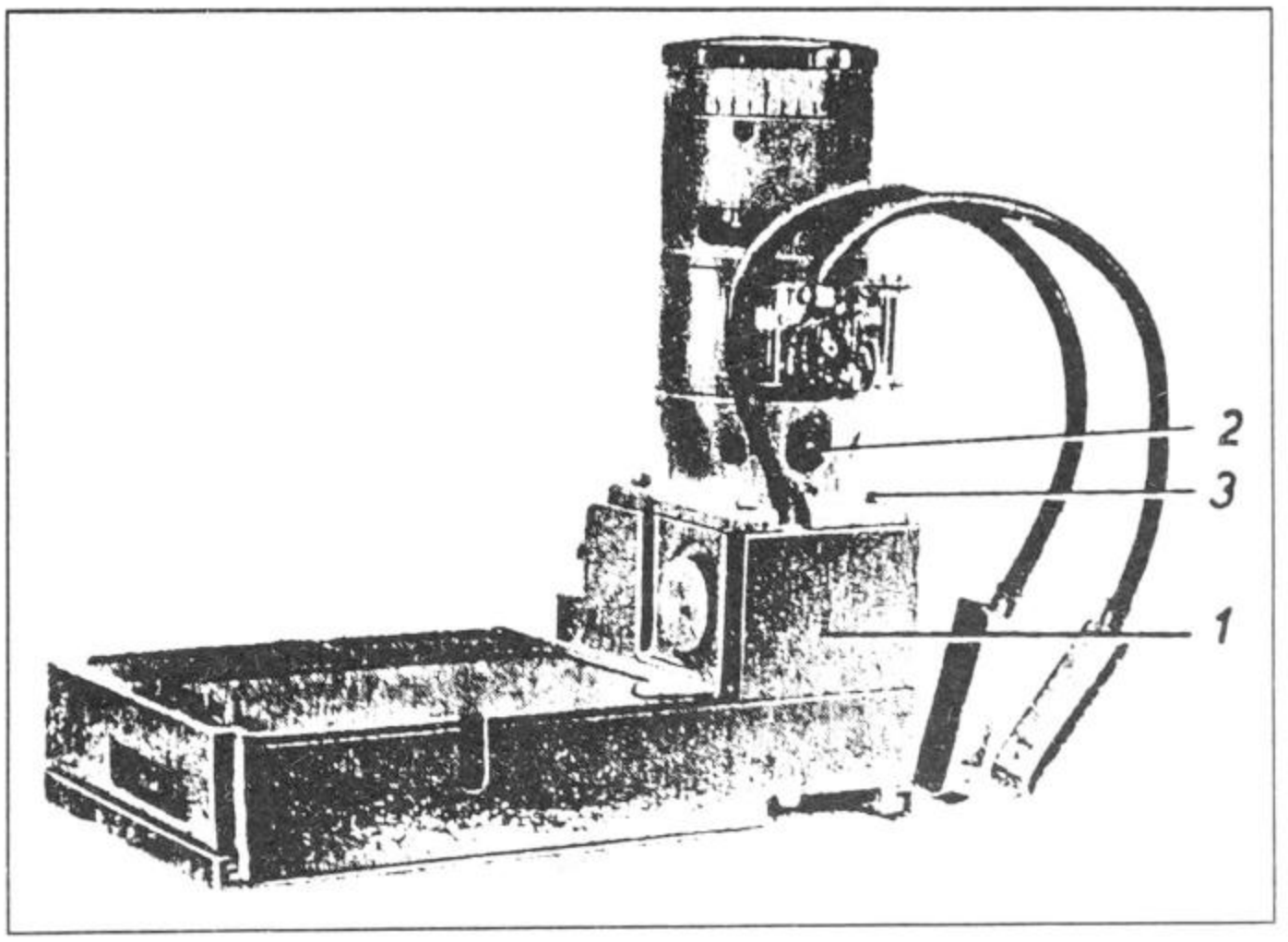


Figure 8.15 *Sender unit without keyboard showing the gear box coverplate (1), generator carbon screwtop (2), motorgenerator screw (3).*

(1) Remove the sender unit according to 2a above, unscrew the safety screws, and remove the protective cap of the sender roll. Remove the two screws in the keyboard and the screw holding the retaining bracket at the back. The sender can be lifted up and removed (see Figure 8.15).

(2) When putting the sender onto the base unit after repairs, the cover plate of the gear box has to be removed by unscrewing the four screws (see Figure 8.15).

(3) Turn the rotary converter by hand until the spring of key E lies in the middle of the cam. Turn the contact roller by hand until the springs are in the middle of the contact segments.

(4) Replace the sender in this position, matching the position of the caps, and secure the screws. Replace the protective cap of the sender roll and replace the screws. Install according to 2b above.

d) Changing the contact roll.

(1) Remove the sender unit as in 2a and 2c above, remove the screws, take off the angular metal sheet, and remove the roller carbon after unscrewing the screw top. Carefully lift the contact roll up and out.

(2) To install, pull the gear stick hard to the back to fasten the contact springs. Then insert the sender roll, replace the angular metal sheet, and loosely fasten the screws. Proceed as in 2c above. Before fastening the protective cap, adjust the nuts in such a way that the cogged wheel of the contact roll fits into the cogged gear wheel. Then tighten the screws, replace the protective cap, and proceed as in 2b above.

e) Changing the test spring.

(1) Remove the contact roll as in 2d above. Then remove the screws and the piece of metal without disconnecting the springs. Remove the spring that relates to the test spring to be changed and remove the test spring.

(2) To replace, stick the new test spring into the guiding slot and push over the guiding stick, reconnect the spring, replace the piece of metal, and fasten the screws. Proceed according to 2d above.

f) Changing the motorgenerator.

(1) Remove the sender unit according to 2a above and remove the protective cap of contact roll. Unscrew the cover at the back of the rotary converter (see Figure 8.14). Remove the four screws of the main plate (see Figure 8.15) and carefully lift out the generator.

(2) To reinstall a new or mended generator, set the red line of the cam to be in line with the one on the center plate. The hinge has to be parallel to the line of the cam. The red line of the generator cam and the one on the ring have to be in line. Carefully replace the generator, making sure the pin of the cam sits in the hole of the hinge. Test if the contact roll can be moved in both directions by turning the generator rotor by hand. Secure the rotary converter with four screws and replace the cover plates. Proceed as in 2b above.

g) Changing the contact plate of the regulator.

(1) Remove as in 2a above, loosen the two screws, and remove the indicator underneath the adjusting ring. Unscrew the regulator cap with adjusting ring counterclockwise. Unsolder the connecting wires and remove NV 5 + 6. Then unscrew the screws and remove the contact plate.

(2) Install the contact plate, secure with screws, solder the connecting wires, fasten 5 + 6, replace the regulator cap, and turn until the number 5 is opposite the two screw holes for the indicator. Replace the indicator and proceed as in 2b above.

h) Changing the sender drive.

(1) Remove as in 2c above. Remove the three screws and lift out the sender drive.

(2) Install in reverse order to h(1), watching for connecting cogged wheels as in 2c above.

i) Changing the main shaft.

(1) Remove as in 2f above, remove the screws, and carefully lift out the main shaft.

(2) Replace in reverse order, watching for connecting cogged wheels. Make sure the red line on the center piece is in *exactly* the same position as before removing the main shaft. Proceed as in 2f above.

j) Changing the writing mechanism.

(1) Put the FTT into working mode. Lift the ink-roll lever to high and remove the paper. Remove the screws and writing mechanism.

(2) To replace the same writing mechanism, carefully line up the cogged wheels and press the tension key. Adjust the writing as in B8 above.

(3) To install a new mechanism, loosen the two screws of the tension key, press down, line up cogged wheels, and fasten. Adjust writing as in B8 above.

k) Changing the paper-feed roll.

(1) Loosen the screw and pull the roll out.

(2) Replace with a new roll and reverse k(1).

l) Changing the drive of the writing spindle.

(1) Remove as in 2j above, loosen the screws, and carefully pull to the front. Remove the paper-feed roll as in 2k. If the drive cannot be easily removed, the sender unit has to be removed as in 2a. Using a wooden stick to put a little pressure on the axle of the drive should help remove it.

(2) Install by reversing l(1), watching for cogged wheels.

m) Changing the contact roll.

(1) Loosen the screws and pull off.

(2) Oil the new roll thoroughly, push on, and secure screws.

n) Changing the paper case.

(1) Depress the appropriate button, keep pressed, and pull out case, right edge first.

(2) To replace a new case, hook the left edge behind the metal pin in the left guider rail and push.

o) Changing the break on the paper plate.

(1) Remove the case as in 2n, unscrew the left guider rail, and remove break.

(2) Reverse O(1) for new break.

p) When changing the carbons, use preground carbons only.

q) Changing the motor carbons.

(1) Unscrew the conducting strands and remove the springs and carbons.

(2) Reverse q(1) for installing.

r) Changing the generator carbons.

(1) Remove the sender unit as in 2a but do not disconnect the cables. Loosen the screws at the front and back of the generator and lift out carbons.

(2) Reverse r(1) to install.

(3) Remove the generator carbons only when the unit is not not in use and is disconnected.

s) Changing the contact roll carbon.

(1) Remove the sender unit as in 2a. Do not disconnect cables. Remove the protective cap from the contact roll, unscrew the screw top, and remove the carbon.

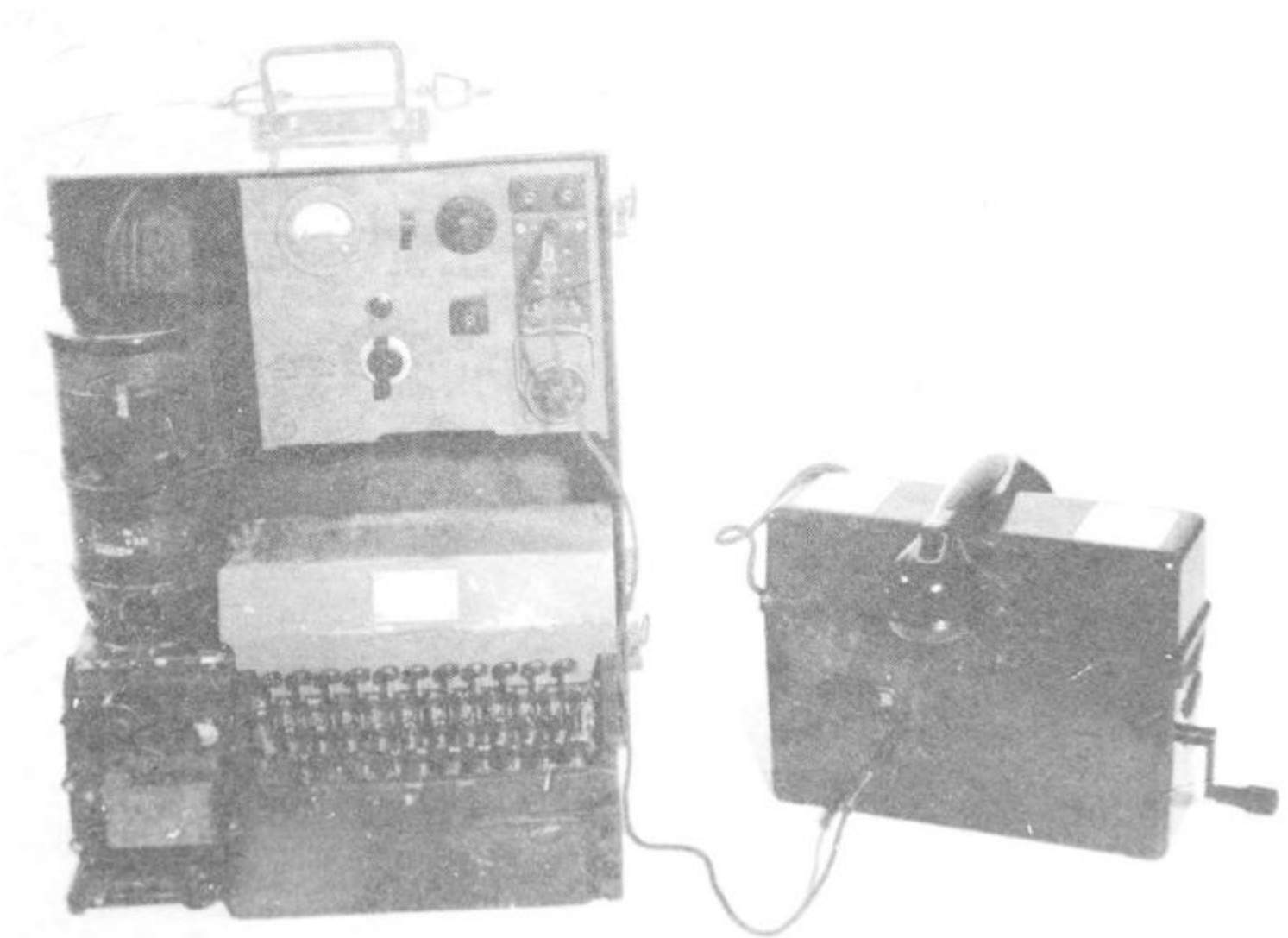


Figure 8.16 *An FTT ready for use.*

(2) Reverse s(1) to install. The carbon must not touch the insulation of the sender roll.

t) When adjusting the leaf spring, if the spring does not press hard enough or presses unevenly, it has to be adjusted so that it just touches the whole width of the paper strip when the lever for the ink roll is lifted by 5 millimeters.

D. Oiling and Greasing the FTT.

1. Oil after one hundred hours or four weeks of use with Shell P37 oil. Use a piece of wire (1 millimeter) that has been dipped into the oil to a depth of 5 millimeters. One drop of oil is enough for any one spot.
2. Oil all friction points.
   a) O marks spots to be oiled.
   b) + marks spots to be greased with weapon grease.
   c) ⊕ marks spots that could get rusty and should be treated with rust protection 40.
3. Clean all parts before oiling or greasing.

CHAPTER 9

The ENIGMA Coding Machine

Army Manual g. 13
Inspection Number 9875
Air Force Manual g. 13

SECRET

OPERATING INSTRUCTIONS FOR CODING MACHINE ENIGMA

dated 12 - 1 - 1937

Unchanged Reprint

BERLIN 1940

Printed by the Imperial Printing Office

I. GENERAL INFORMATION

A. The ENIGMA coding machine is a secret item within the meaning of the Classified Items Regulation. In accordance with this regulation, the item will be kept in places inaccessible to unauthorized persons.

B. Users of this machine must be aware that its construction calls for careful handling and maintenance so that the machine is at all times operational.

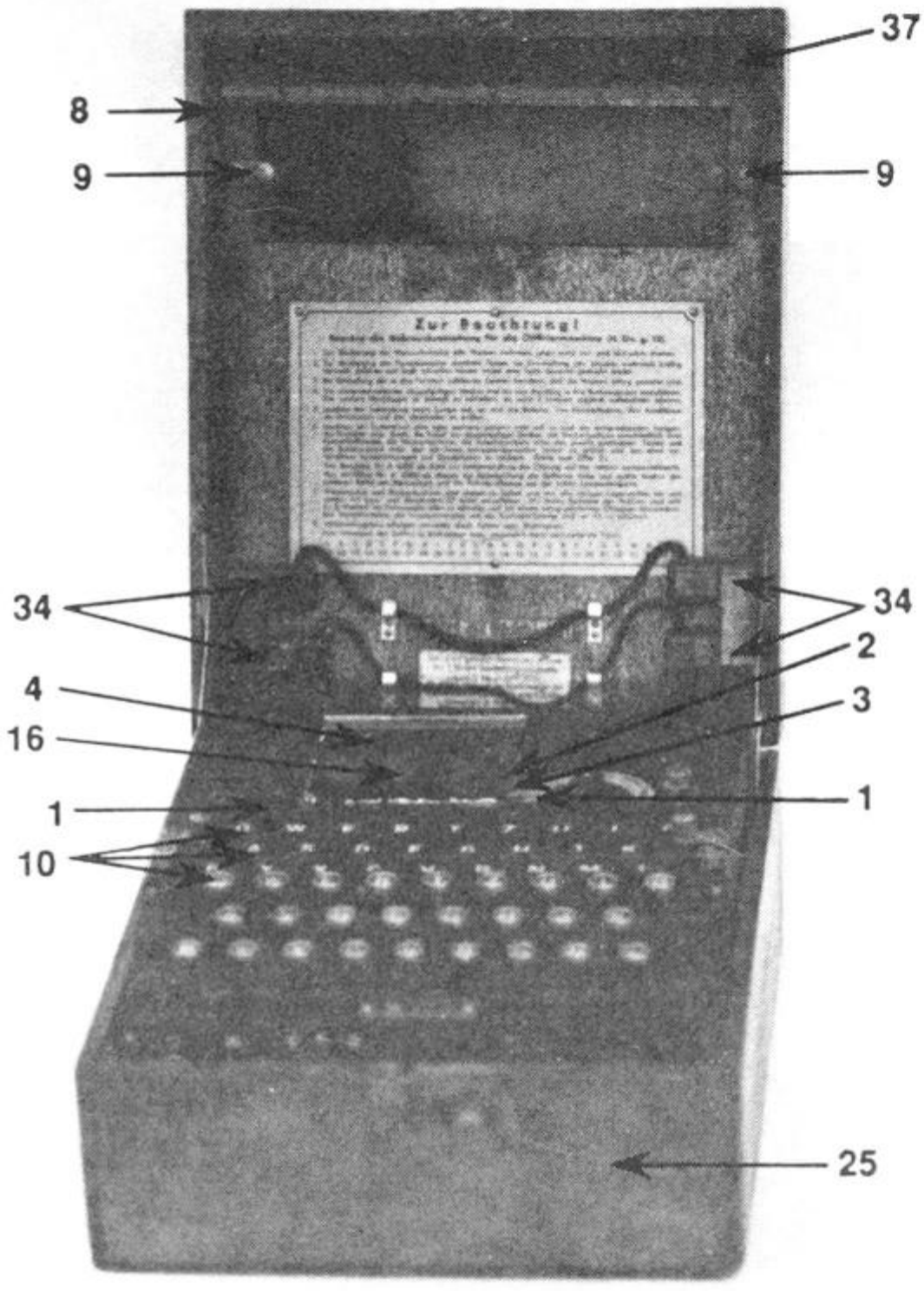


Figure 9.1 *Clockwise from top right: spare light bulbs (37), lamp-filter latch (9), spare patch cords (34), spring-loaded buttons (2), spring support levers (3), latch (1), front cover (25), letter transparencies (10), windows (16), cover plate (4), lamp filter/Zellon plate (8).*

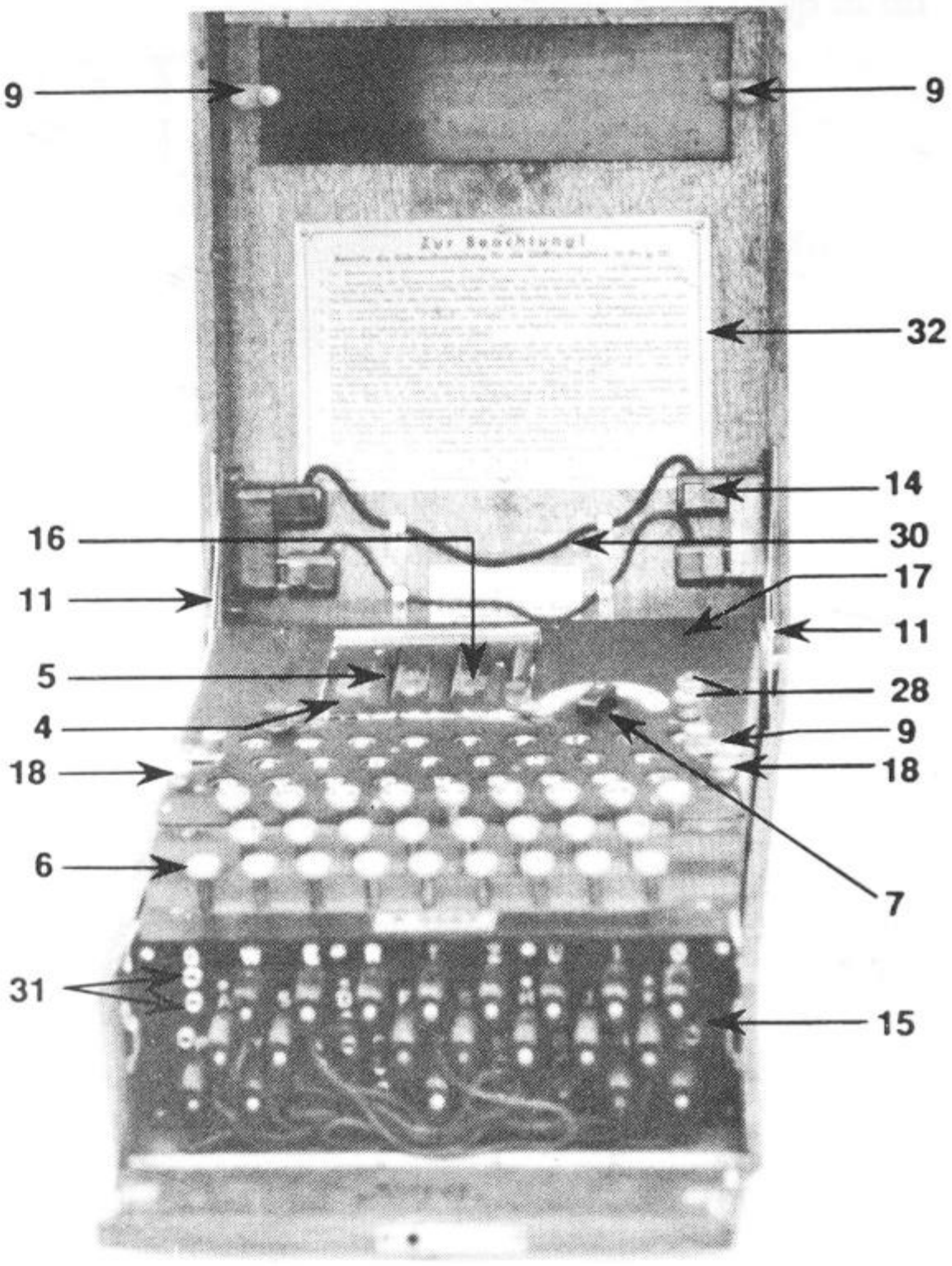


Figure 9.2 *Clockwise from top right: lamp-filter latch (9), operating instructions (32), patch cord (14), double-plug cables (30), metal cover (17), cover hinges (11), terminals for battery (28), key levers (29), retainer screws (18), battery switch (7), socket board (15), plug sockets (31), keys (6), cover plate (4), setting disks (5), windows (16).*

II. PREPARING MACHINE FOR OPERATIONS

A. Prior to use of the machine, check for faultless operation. For this purpose, open the wooden container, release the support mechanism by lifting the spring-loaded buttons, and swing the support levers around. The cover plate can now be lifted and the setting disks will become visible.

B. Turn setting disks several times in opposite directions so that the coding cylinder contacts become clean, then close the cover plate and secure it by operating the support levers.

C. To clean the key contacts, push down hard on all keys and release quickly. Do this several times prior to switching on the power supply. During this operation, hold one key in the down position to avoid unnecessary movement of the cylinders.

D. If the battery has recently been charged, move the battery switch from *Aus* to *Dunkel* (dark). When the battery charge deteriorates after prolonged use, move the battery switch to the *Hell* (light) position to ensure the brightness of incandescent lights. Moving the switch to *Hell* too early during operation causes premature failure of the incandescent bulbs.

E. In sunshine and for eye protection, it is advisable to remove the green *Zellon* plate from under the wooden cover by lifting and turning the spring buttons and, using the same components, securing it over the letter transparency. The *Zellon* plate softens the glare of the incandescent lights and covers all other letters, allowing only one letter to be illuminated.

F. For protection against bright sunlight, the machine can be shaded by pulling forward the joints of the cover hinges and half closing the wooden cover.

G. A clip to retain the sheet of paper is located on the underside of the cover to ensure easy reading of the passages to be encoded.

III. SETTING THE CYPHER

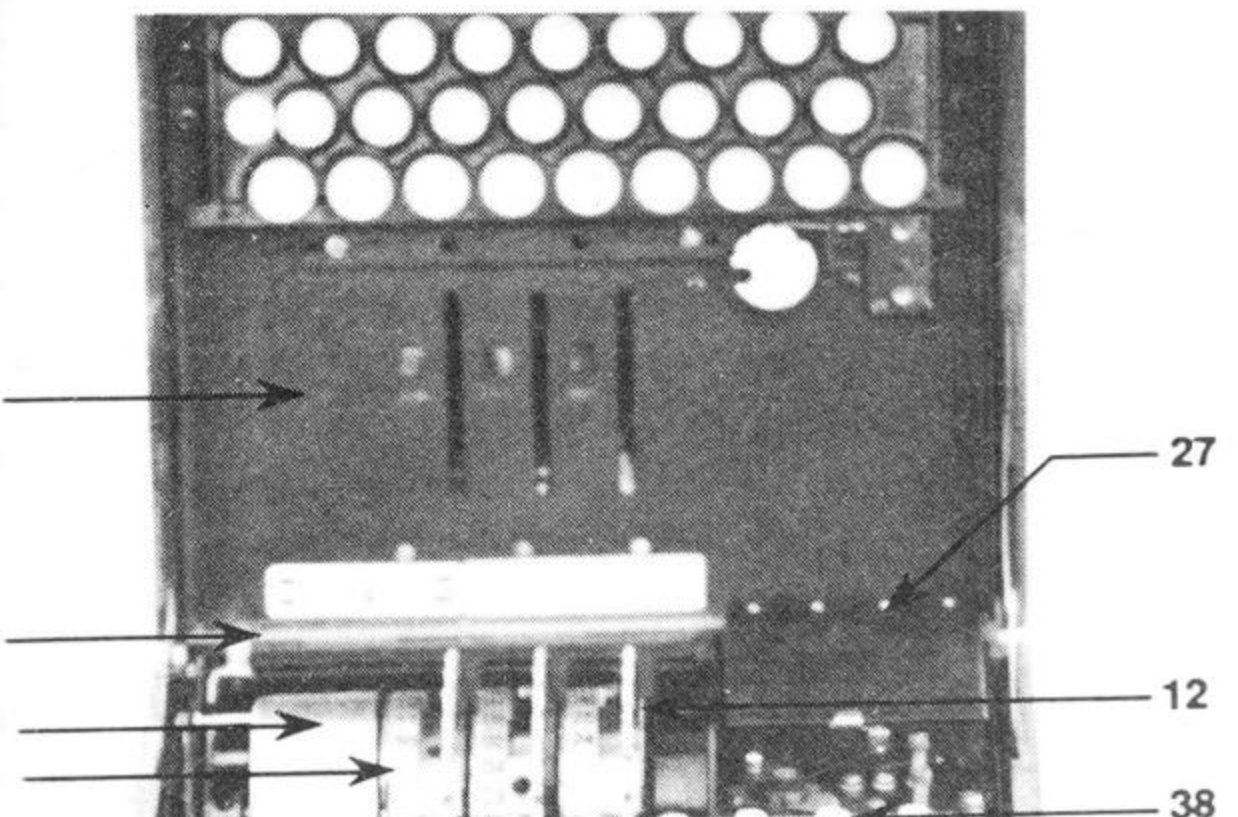
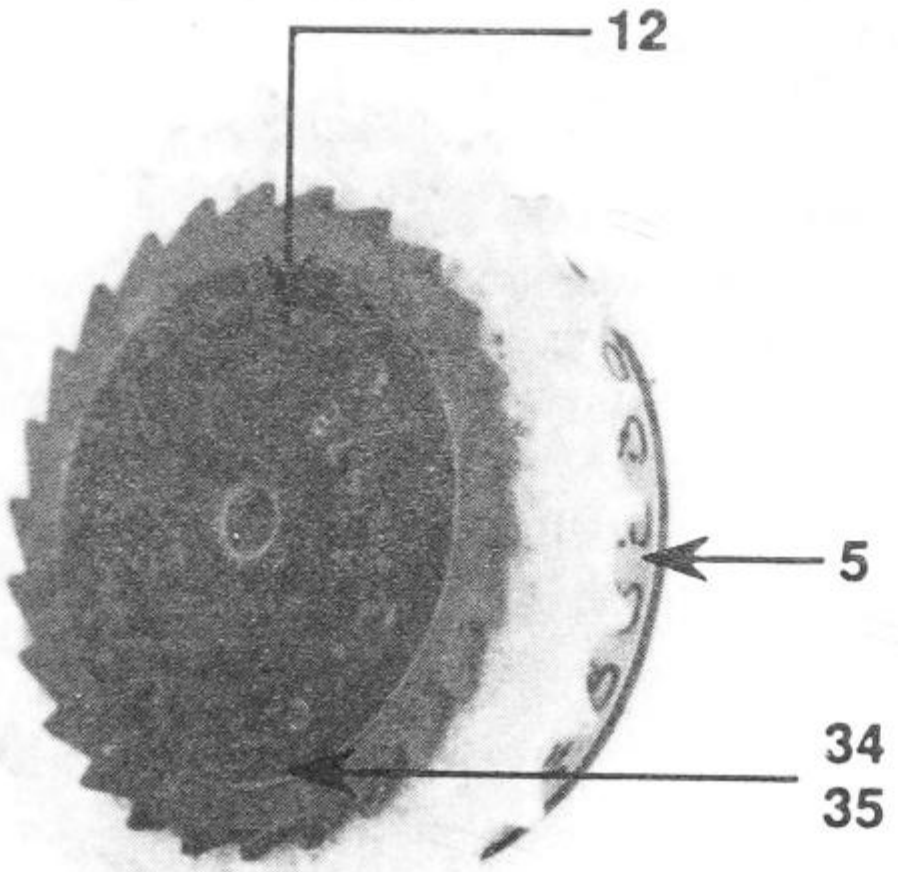


Figure 9.3 *Clockwise from top right: battery box (27), coding cylinders (12), light bulbs (38), testing light sockets (39), hooks (26), unused patch panel sockets (41), patch cord test socket (40), code numbers (13), reversing cylinders (20), lever (19), metal cover (17).*



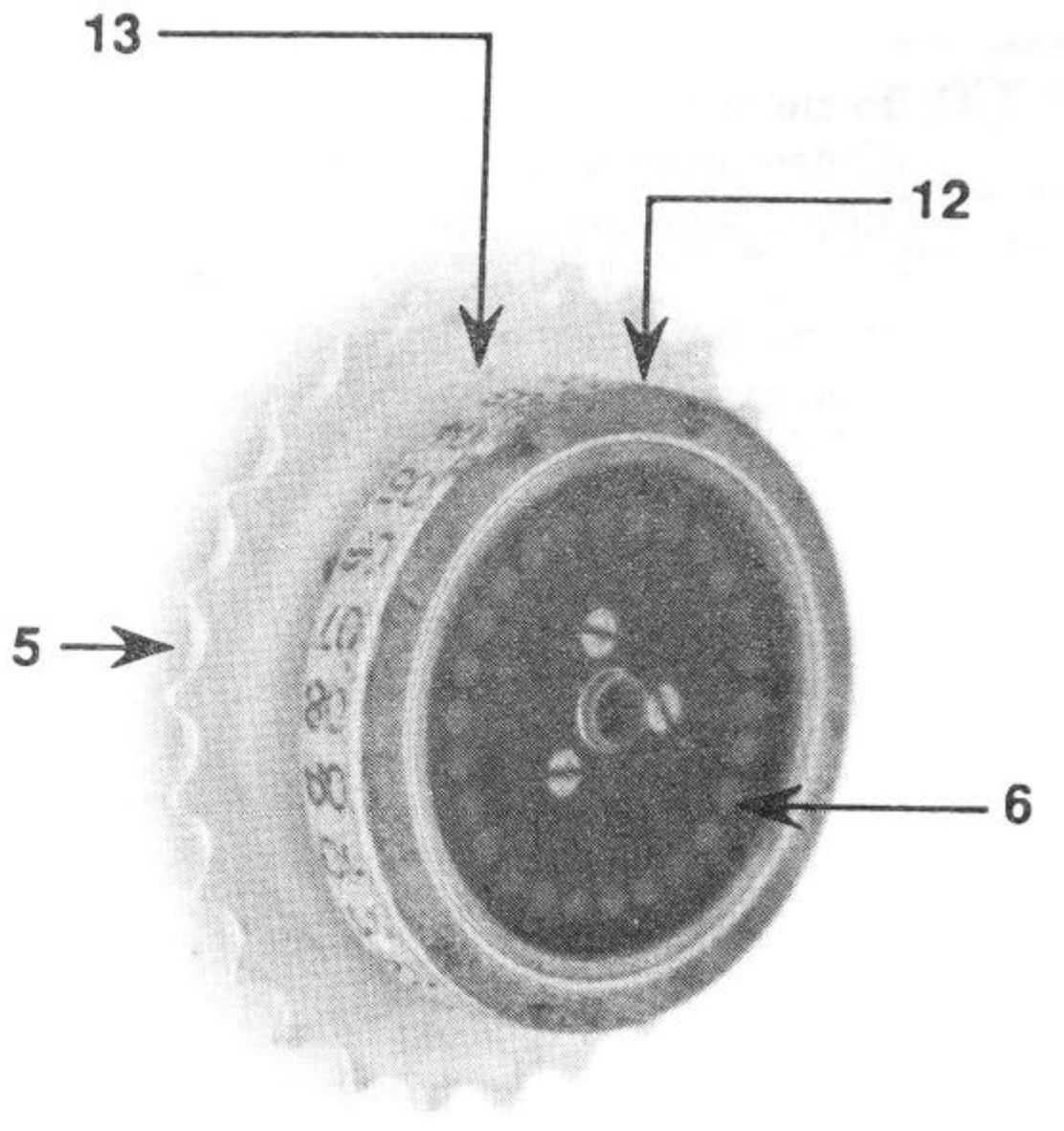
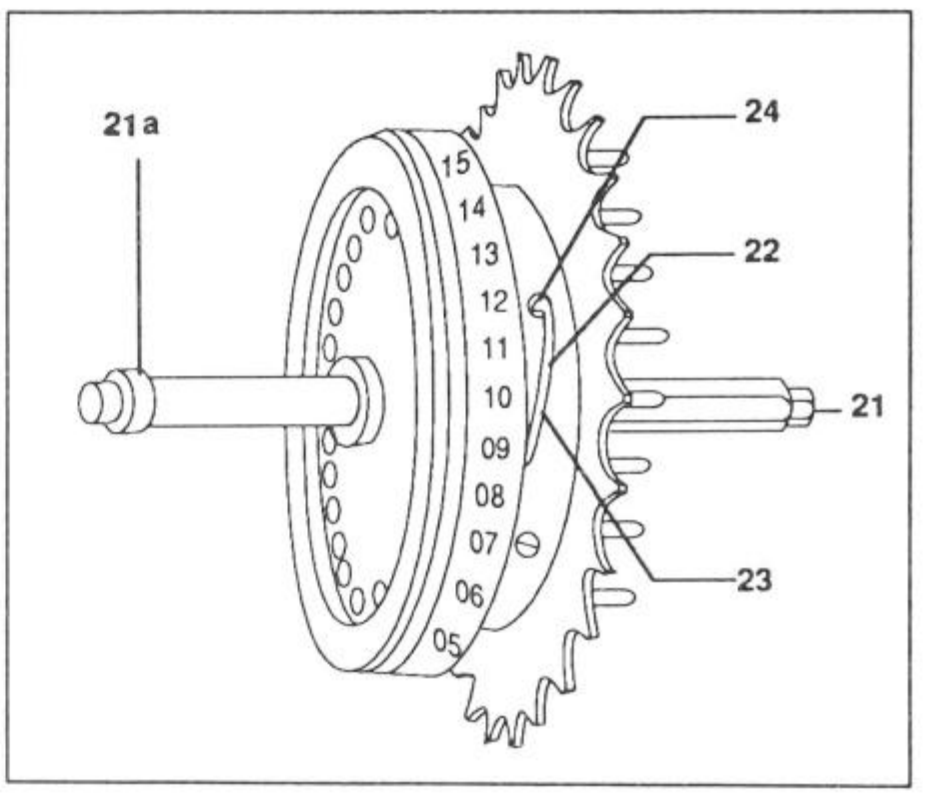


Figure 9.4A (top left): *coding cylinders (12), setting disks (5), spring-loaded contact pins (34), coding cylinder contact pins (35).* ***Figure 9.4B (top right):*** *setting disks (5), code numbers (13), coding cylinders (12), smooth contact points (36).* ***Figure 9.4C (right):*** *axle collar (21a), spring stud (24), retainer spring (22), axle (21), retainer spring button (23).*



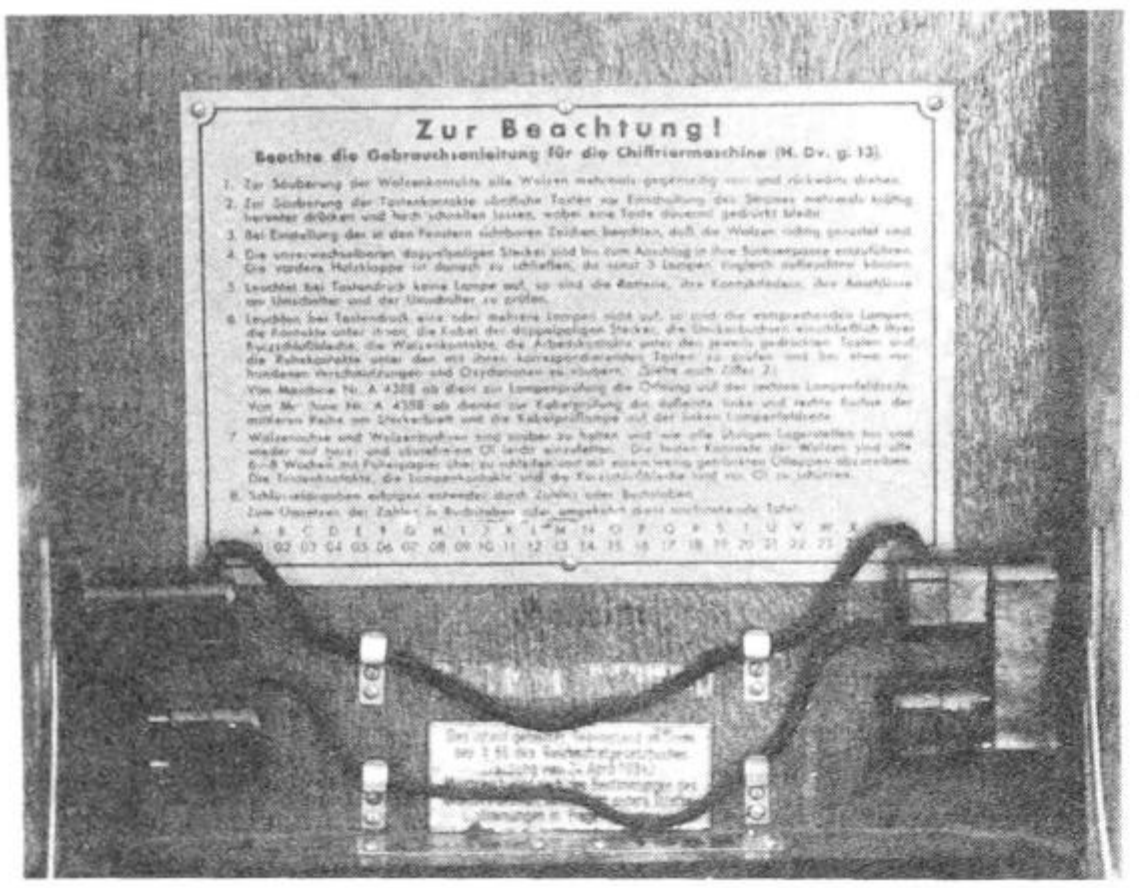


Figure 9.5 *Close-up view of the operating instructions and patch cords.*

A. The cypher issued for the machine determines the following four settings:
   1. Sequence of coding cylinders (position of cylinder).
   2. Setting of number or letter rings on the three coding cylinders (ring position).
   3. Setting of numbers or letters to be visible in the windows (normal position).
   4. Plug connections on the socket board using double-plug cables (plug-in connections).

B. The setting of the cypher is accomplished by opening the metal machine cover by unscrewing both retainer screws, lifting the cover up by the screws, and pulling it forward.

C. The cylinders are marked with Roman numerals on the sides where the spring-loaded contact pins are located, and with a number of black dots corresponding to these numerals, so that the cylinder sequence may be checked initially without removing them.
1. To obtain the correct cylinder position, the lever in the left-rear corner is folded forward right up to the stop and the reversing cylinder is pushed sharply to the left. After this, compress the coding cylinders by pushing the setting disks to the left with your right hand. The coding cylinders are then removed together with the axle.
2. Push the cylinders onto the axle in the sequence determined by the cypher and, by compressing them, place them back into the machine. When pushing the cylinders onto the axle, make sure that the sides with the smooth contact areas are at all times pointing to the side of the axle collar and that, when placing the cylinders that have been pushed onto the axle back into the machine, the axle collar with the smooth contact areas is always turned toward the reversing cylinder. After placing the cylinders back into the machine, move the lever back to the rear until it clicks into position.
3. When removing and subsequently placing coding cylinders back into the machine, make sure that the necessary care is taken to ensure that the protruding contact pins of the reversing cylinder are not bent by the left bearing stud. Care must also be taken that, after pushing back the lever, the cylinders snap in position properly, which can be verified by checking if the numerals or numbers are located in the center of the windows (check by turning individual coding cylinders).

D. To set the correct ring positions, lift the retainer springs of the rings that show the numerals and numbers by grasping the knob provided on each spring with the right hand and turning the rings with the left hand until the spring stud—which, from machine No. 1253 on, is provided with a red marker—snaps into the hole located next to the numeral prescribed by the cypher. Then close the metal cover and tighten both screws.

E. To set the normal position, open the cover plate and use the adjusting knobs to turn the coding cylinders until the numerals and letter prescribed by the cypher for the normal position become visible in the windows. Close the cover plate.

F. To establish plug-in connections, loosen the hooks located at the front plate and let down the plate. This gives access to twenty-six pairs of plug sockets that are marked by letters A through Z and, simultaneously, with corresponding numerals 1 through 26. The cable-connected pairs of double plugs are pulled out individually by the plug handles (do not pull on the cable). In accordance with the plug connec-

Figure 9.6 *The ENIGMA coding machine in use.*

tions as prescribed by the cypher, establish connection between a number of pairs of sockets using the cable-connected double plugs. Sockets and plug pairs have been designed so that they cannot be confused. Be sure to push the plugs as far down as possible into the sockets to prevent a simultaneous lighting up of several incandescent lights. Close the front cover and secure with it hooks.

G. Having set the cypher, feed the message text in the clear letter by letter into the machine in the same manner as you would do on a typewriter. Depress the keys all the way down until a letter lights up in the transparency and/or the *Zellon* plate placed over it. The next key must not be depressed before the preceding key has been released and has snapped back into its normal position. For details of the coding procedure see *Schluesselanleitung zur Chiffriermaschinen Enigma* (Army Manual g.14).

V. DECODING

Set the machine in accordance with the prescribed cypher (see III above) and then decode in the same manner as when encoding (see IV above), but instead of the letters of the clear text, key in the letters of the encoded message.

VI. KEYING ERRORS AND MALFUNCTIONS

A. In the event that errors have been made when encoding or decoding by pushing the wrong keys or by machine malfunctions (failure of incandescent lights), repeat the encoding or decoding procedure starting at the *beginning of the message*. To do so, set the cypher in the windows in the same manner as at the start of the procedure. However, in the event that an error is made at the end of the decoding or encoding process, set the key again and depress any one key as often as letters were correctly keyed prior to the occurrence of the error to avoid having to repeat the entire coding process.

EXAMPLE: If, during coding, the thirty-second letter is fed in erroneously, a random letter is keyed thirty times after resetting the cypher in the window, whereupon the thirty-first letter of the message is fed in by depressing the appropriate key for control purposes and comparing it with the letter that was produced by the first encoding. In the event that this comparison produces the same letter as during the first encoding, proceed normally with the thirty-second letter and the letters following thereafter.

B. If long messages must be processed, the correction of mistakes can be simplified considerably by writing down the numeral that simultaneously appears in the window after about every fiftieth letter. To correct the mistake, proceed back to the last letter taken down in the aforementioned manner and, after setting the appropriate numeral in the window, repeat the coding process from there on.

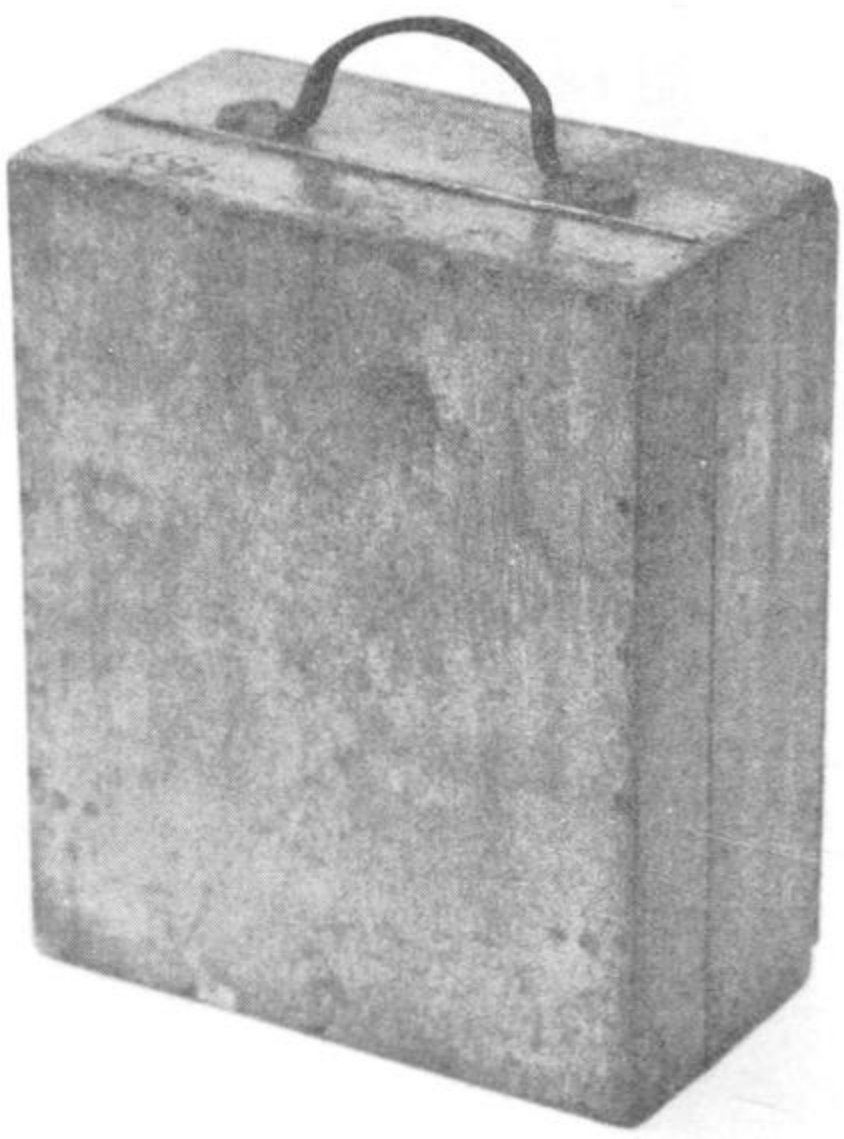


Figure 9.7 *The ENIGMA machine in transport configuration. This particular example has a wooden case; others have metal cases.*

VII. POWER SOURCE, INCANDESCENT LIGHTS

A. General operating instructions are printed on the inside of the cover of the machine; this is to ensure that, without having to consult the operator's manual, insignificant malfunctions may be remedied.

B. Battery 4.5 KZT 5 must be used in the machine. Such batteries may be obtained from the Ordnance Depot (comm), where they are held in storage. In the event that no usable batteries are available, connect into any power source (flashlight battery, storage battery, and such like) using the two thumbscrews provided. Care must be taken to ensure that the power source has a maximum voltage of 4 volts. To operate the machine with a power source connected to the machine through the two thumbscrews, turn the battery switch to *Sammler* (storage battery).

C. When replacing the battery, the cover of the battery box, which has become accessible after opening the metal cover, must be opened and the old battery pulled out and replaced by a new one. In doing so, care must be taken to ensure that the contact springs of the new battery point to the right (see also position of mating contact springs within the battery box).

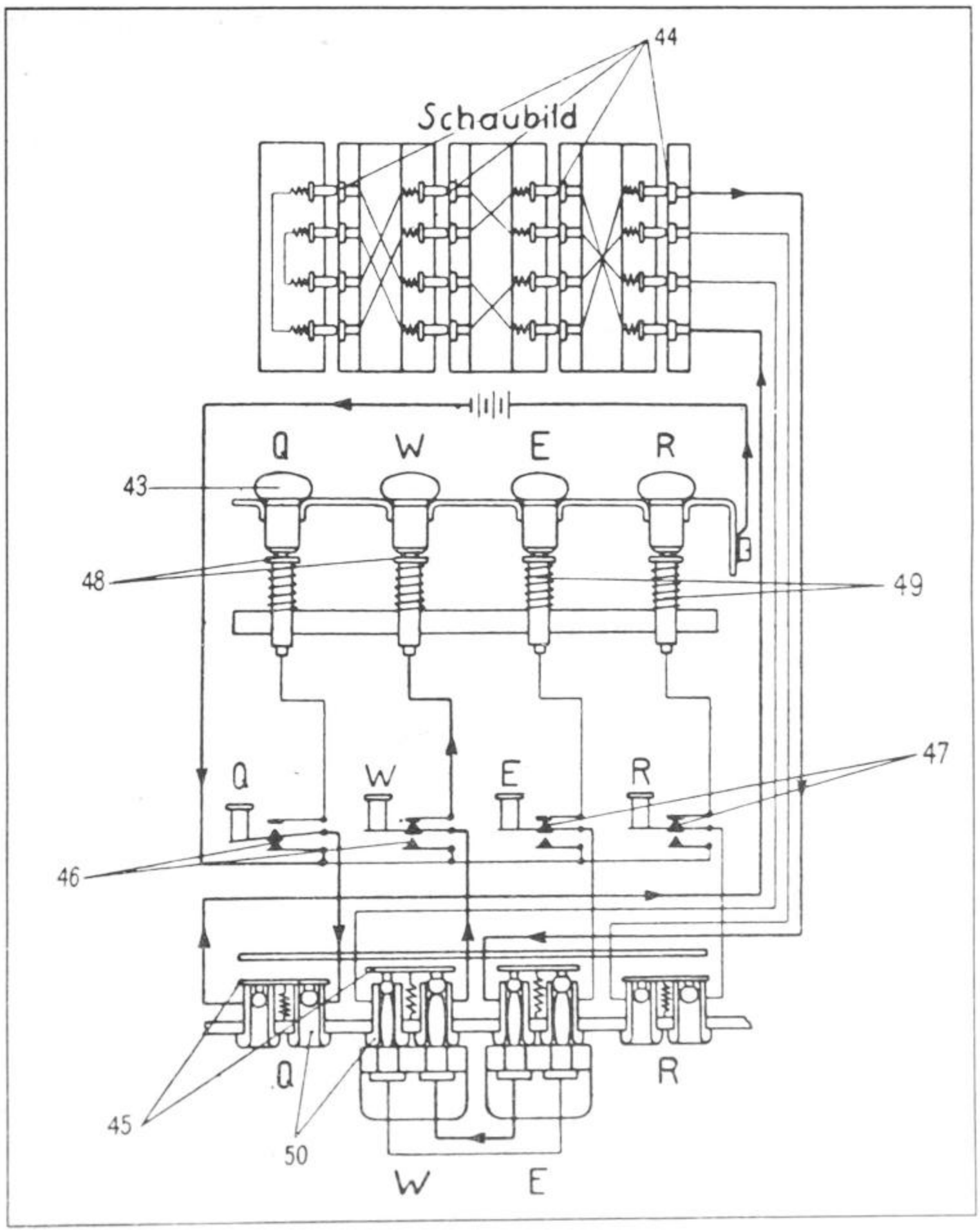


Figure 9.8. *Clockwise from top: rotor contacts (44), lamp contact springs (49), key contacts N.C. (47), jacks in patch panel (50), bypass contacts for unused patch panel sockets (45), key contacts N.O. (46), lamp contacts (48), light bulbs (43).*

D. Incandescent lights used in the coding machine comply with the following specifications: hemispherical, 12 millimeters, 3.5 volts, .2 amperes, acid-free soldering, base-nickel plated. There are twelve spare bulbs on a strip of metal located at the upper edge of the wooden cover. Commercial torch batteries with a diameter of 12 millimeters may be used in emergencies; they must, however, be replaced as soon as possible since they are prone to malfunctions. Machines marked with number 4388 and higher have an opening to the right of the incandescent lights area marked "testing." By inserting individual bulbs into this opening and placing the arm of the switch in position *Dunkel* or *Hell*, individual bulbs may be tested as to their serviceability (be sure to pull the bulbs out of this opening immediately following the test).

E. Each machine is provided with eight double-plug cables, two of which may be accommodated under the cover of the machine. As of machine number 4388, two sockets (the extreme left and the extreme right—with red markings—of the middle row on the socket board) and the light marked *Kabelprüfung* (cable test) are located on the left side of the incandescent light area so that the conductivity of the double-plug cables and their serviceability may be tested. The two sockets cannot be confused and are switched in a manner by which, when inserting the respective plug prong of each double plug into these sockets, the test light comes on. At the same time, check the double-plug cable for breaks.

VIII. MALFUNCTIONS

A. Malfunctions that can be rectified by operators are usually bad connections that are traced and identified as follows.

B. To ascertain whether or not incandescent lights, cylinder contacts, and metal short-circuit strips of the socket board are in working order, the Q key must be depressed in any cypher setting, whereby any letter (e.g., letter W) will light up. While keeping the Q key depressed, depress the key of the corresponding light (in our case the W) whereby, after releasing the Q key, letter Q will light up. The W key is kept depressed and, for example, the E key is now pushed, which again causes a letter, (e.g., letter R) to light up. Now release the key and depress the R key, then release the E key, which will cause the letter E to light up. Then, for example, push the T key and so on. In this manner you can test the whole alphabet without having to change the cypher setting in the windows.

C. If this test is conducted and a malfunction of one or two of the corresponding lights is ascertained, the following tests must be conducted and/or malfunctions eliminated:
1. The contact prongs of the coding cylinder and those of the reversing cylinder are cleaned within the machine or after their removal from the machine by rubbing the tops clean with a polishing cloth. At the same time, check if individual prongs stick, in which case clean them with a cleansing agent and thinly coat them with acid-free grease. If the machine is continuously used, the contact points of the cylinder must be sanded every six to eight weeks—or, accordingly, at longer intervals—and treated with a damp oil cloth. All key contacts, bulb contacts, metal short-circuit strips, and other contacts must be thoroughly protected from contact with oily liquids.
2. When testing bulb contacts, the incandescent lights must be removed from their positions. Then the mating contacts must be depressed, after which, by retightening the non-operating lights, these must be tested for proper contacts, having already previously tested the serviceability of the two incandescent lights (see VII D above). If the machine does not have instrumentation for testing lights, use the two poles of the battery to test lights.
3. The cables of the double plugs must be tested in accordance with VII E above. (If the machine is not yet equipped with instrumentation to test cables, establish direct contact

with the two poles of the battery using an incandescent light.) If required, exchange defective cables.
4. By repeatedly inserting double plugs into and removing them rapidly from the corresponding pairs of sockets, the spring-loaded contact lamellas (metal short-circuit sheets) must be pushed away from the sockets and allowed to jump back sharply against the sockets.

Figure 9.9 *Front cover from an original commercial sales brochure for the Chiffriermaschinen. Originally designed for commercial business use, the machine was impractical and unsuccessful until adapted for military use.*

5. To clean the two respective key contacts, the associated keys must be depressed several times vigorously and released quickly (as in II 5 above) while keeping a third key depressed permanently so as to prevent the cylinder from moving to the next position.
6. Under no circumstance should individual contacts be touched with hands.

D. In the event that *all* lights fail to function, it is likely that the battery is empty or the ends of the prongs are in contact with the springs of the battery box. Eliminate this malfunction by changing the battery in accordance with VI B above or by bending the spring and thus establishing contact.

E. If malfunctions cannot be eliminated after tests conducted in the above manner, further repair work can only be done in the workshops of signal battalions and army ordnance supply depots and/or air force signal supply depots in accordance with special instructions.

F. Under no circumstance will repair work be carried out on coding machines. If repairs are necessary, machines will be sent to the army ordnance depot (signals) by units in the army high command area;

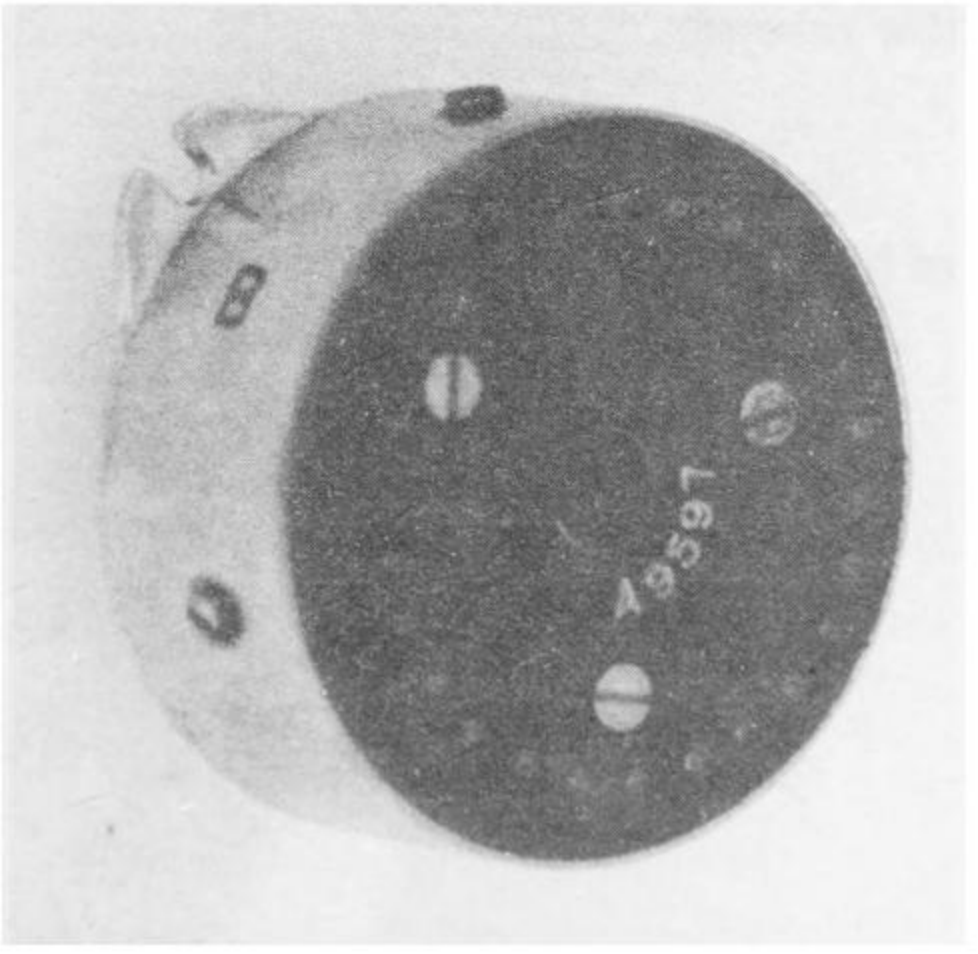


Figure 9.10 *Close-up view of an internal section of the rotor. Note the contact pins and serial number near the center hole.*

for those in the high command of the air forces area, machines will be sent to the air force signal supply depot.

IX. MAINTENANCE

A. The axles of the coding cylinder and the drive-shaft bearings will be cleaned and treated with acid-free and nonresinous oil every six to eight weeks if the machine is operated permanently; in normal operations, maintain at three-month intervals. Great care must be taken that no oil comes in contact with any of the key contacts, bulb contacts, and short-circuit strips.

B. To protect the inside of machine from dust and similar substances, always keep the metal cover and cover plate closed. As soon as the machine is no longer operated, move the battery switch to *Aus* and close the wooden-box cover.

Berlin, 12 January 1937

The Imperial Minister of War and
Commander in Chief of the Armed Forces
by direction
Fellgiebel

CHAPTER 10

Coding Instructions for the ENIGMA Coding Machine

Army Manual g. 14
Navy Manual No. 168
Air Force Manual g. 14

Control No. 9875

SECRET

Coding Instructions
for
Coding Machine ENIGMA
dated 13 Jan 40

Reprint with included Change Sheets 1 - 8

Berlin 1940
Printed by the Imperial Printing Office

I. DEFINITIONS OF TERMS AND MARKINGS

A. "Coding" may be encoding or decoding.

B. "Coding means" is the supplemental equipment required; i.e., coding machine (hereafter called "cyphering machine").

C. "Coding procedure" is the rule on which the coding process is based.

D. "Coding table" is the listing of individual cyphers for an extended time period.

E. "Cypher" is the alternating documentation used to prepare the coding machine for coding in accordance with individual procedures.

F. "Decoding" is changing an encoded text into a clear text.

G. "Encoding" is changing the clear text into an encoded text.

H. "Identification group" is used to identify the cypher that is used to process the message.

I. "Secret text" or "encoded text" is a clear text that has been changed in accordance with a certain cypher.

J. "Text in clear" or "open wording" is a message written in open speech.

II. GENERAL DATA

A. The extent to which the ENIGMA coding machine is to be used will be the subject of a separate order to be issued by the supreme command for the individual elements of the German armed forces.

B. The general rules for coding are contained in armed forces manual *Allgemeine Schlüsselregeln* (general coding instructions; army manual g.7, navy manual 534, air force manual g.7). The instructions for the operation of the ENIGMA coding machine are contained in the *Gebrauchsanleitung für die Schlüsselmaschine ENIGMA* (operator's manual for ENIGMA Coding Machine; army manual g.13, air force manual g.13).

C There is no minimum length prescribed for a message to be encoded or decoded on the ENIGMA Coding Machine. The maximum length of a message to be transmitted must not exceed 250 letters.

D The message heading contains:

1. The time, four digits; e.g., 1755.
2. The number of letters including the five letters of the identifier group.
3. The selected normal position, e.g., WEP, and the encoded message cypher, e.g., HFI.

III. CODING DOCUMENTATION

A. The cypher changes daily ("daily cypher") at 0000 hours. The cyphers and their identifiers (see IV below) are issued in a *Schlüsseltafel* (coding table) containing a summary of individual daily cyphers and identifiers which, as a rule, are issued for one month.

B. The following information, which changes daily, is supplied with the cypher and changes daily:
1. Cylinder position (Roman numerals).
2. Ring position (Arabic numerals or letters).
3. Plug-in connections (letters).

C. In so far as code information is expressed by letters or numerals, the latter will be used in place of letters or vice versa according to their sequence within the alphabet.

A	B	C	D	E
01	02	03	04	05

(Note that there is a separate letter J in addition to the I in the coding machine, meaning that the alphabet has 26 letters!)

D. Examples.
1. The cylinder position denotes the sequence in which the individual coding cylinders are to be inserted into the ENIGMA coding machine from left to right.
2. The ring position denotes the positioning of letter or numeral rings on each individual cylinder.
3. Specifying the plug-in connections identifies the socket pairs that must be connected by the double-plug cable.

NOTE: Each letter identifies a certain socket pair, and two letters printed together denote those socket pairs that have to be connected, e.g.:

AO BI DV EH GZ KW LX MU RY QT

IV. IDENTIFYING THE CYPHER

A. The cypher used for a message is identified by a five-digit letter identifier group. The first two letters (filler letters) of this group may be selected at random and, in order not to disclose the identifier group, must be changed for each message. The *last three* letters ("identifier group letters") are taken from the *Kenngruppentafel* (identifier group table). Each cypher area and day has several identifier groups consisting of three letters each. These groups of letters must be used alternatingly; in so doing, the sequence of the individual letters within this group must be changed for each message.

B. In messages consisting of several parts, *each individual part* will be identified using different identifier group letters and different filler letters.

C. The identifier group (two filler letters plus three identifier group letters) must be placed at the beginning of the message as the first group before the encoded message cypher. The five letters of the identifier group must be counted towards the number of letters contained in the message heading. *Identifier groups will not be encoded.* Prior to encoding the message, they will be written on the message form as the first group and, after establishing the cypher area, must be deleted prior to encoding the message.

V. ENCODING

A. The ENIGMA coding machine is prepared for transmission on the basis of the coding information contained in the daily cypher. This process is identical for all agencies using the same cypher (i.e., cypher for armed forces machines). The encoder takes three identifier group letters from the coding table and fills them up by placing two randomly selected filler letters in front, thus creating a group of five letters that he writes down on the message form as the first group of the message to be transmitted. The encoder then selects a special normal position for *each* message and adjusts the machine accordingly. The normal position prescribes the numerals or letters that have to be set in the windows of the coding machine from left to right. For example:

W E P - 23 05 16.

B. The normal position must differ for each message; if messages consist of several parts, *it has to be different for each part*. In messages consisting of several parts, under no circumstances may the position resulting in the windows of the coding machine at the end of the preceding part be selected as the normal position or message cypher for the following part of the message. When selecting the normal position, the instructions for selecting the message cyphers must be observed. *The normal position and message cypher may not be identical.*

C. Each message must be encoded in accordance with a particular message cypher, which is selected by the encoder himself, from the letters and/or numerals for the three rings A A A through Z Z Z (01 01 01 through 26 26 26). When selecting individual cyphers, it is not permitted to use identical letters (AAA), words (sic: ist), abbreviations (sic: Rgt.), call signs of the transmission area, code signs (QRM), letters in the key sequence of the coding machine (ERT), or letters in alphabetical sequence (forward or reverse: ABC, CBA). For *every* message and *for each part* of a message consisting of several parts, a new message cypher will be used.

D. The message cypher selected by the encoder (e.g., XFR - 24 06 18) will be keyed once into coding machine ENIGMA, which has been set on the basis of the daily cypher and the selected normal position. The three illuminated secret letters will be added to the three letters of the normal position contained in the message heading.

E. The encoder then sets the letters selected as the message cypher (e.g., XFR - 24 06 18) under the windows and keys the clear text. The letters illuminated during this procedure are written on the message form behind the five letters of the identifier group as the sixth, seventh, and eighth letters and combined to form five-digit letter groups.

VI. DECODING

A. From the received encoded text, the cypher that was used must be identified on the basis of the identifier group tables printed onto the individual coding tables. The identifier group must then be deleted (see also IV above). The coding machine must then be set in accordance with the valid daily cypher; the normal position is to be taken from the heading of the encoded message received.

B. To decode, the coder must first establish the cypher (see V: B and C) used in the message. To do so, the three letters of the encoded message cypher, which are located in the message heading behind the three letters of the normal position, are keyed. They represent the three-digit message cypher.

C. The coder then places the cylinder in position under the windows of the machine in accordance with the message cypher obtained and, from the sixth letter, keys the encoded message. The letters that are illuminated in this process are written down and represent the message text in clear.

VII. ALTERNATE AND EMERGENCY CYPHERS

A. Every cypher has a replacement cypher or manual cypher, of which the latter is issued in accordance with the *Wehrmacht-Handschlüsselverfahren* (armed forces manual cyphering procedure; army manual g 15a and 15b). In the event of a compromise or loss of the machine cypher, the replacement cypher then replaces the machine cypher and will be used by all units and agencies working with the same cypher table.

VIII. EXAMPLE

A. The effective daily cypher is extracted from the cypher table applicable to the encoding of the clear message text (e.g., armed forces machine cypher for the month of May).

Date	Drum Position	Ring Position
4th	I III II	16 11 13

Plug-in Connection	Identifier Group
BN KE VZ CO DI FR HY JW LS TX	adq nuz opw vxz

This daily cypher is to be used to set the coding machine (see III B, C, and D above).

B. Encoding.

1. The text to be encoded in the following example has been selected at random. For security reasons, it was not keyed with the coding machine. The message to be encoded:

> *Tag 4.5., Abgangszeit 17.55 Uhr, Gen. Kdo VI, angreift 5. Mai 0345 Uhr mit 3. und 10. Div. Feind bei Maisach. Gef. Stand Milbertshofen Nordausgang.*
>
> (Day 4.5, Time transmitted: 17.55 hours, VI Army Corps to attack 5 May 0345 hrs with 3rd and l0th division enemy near Maisach. CP at northern exit of Milbertshofen.)

2. For the encoding of this message, the clear text will be written down as follows in accordance with army manual g.7, navy manual 534, and air force manual g.7:

> gen kdo roem s e q s angreift fuenften mai null drei vier fuenf uhr mit dritter und zehnter div feind bei maisach x gef stand milbertshofen nordausgang
>
> (Roman six army corps to attack fifth may zero three four five hrs with third and tenth division enemy near maisach x comd post northern exist milbertshofen)

3. The coder then sets the ENIGMA coding machine according to the daily cypher. He then enters the identifier group as the first group on the message form, selects for each message or, respectively, for each part of a message (in the event that a message consists of several parts) one special normal position (such as WEP - 23 05 16) and sets this normal position in the windows of the ENIGMA coding machine (see V: A above).
4. He then selects a message cypher (e.g., XFR - 24 06 18) and keys these letters in once, which results in the generation of letters HFI that will have to be written down after the normal position (WEP) in the message heading.
5. Now the coder enters the letters that were selected as the message cypher (e.g., XFR - 24 06 18), with the coding machine remaining set as before, and allows them to appear in the windows. He then keys in the clear text. The letters thus resulting are written down subsequent to the five letters of the identifier group as letters 6, 7, 8, and so on; at the same time, groups of five letters are formed. The following coded text then results:

ulznu	sgexu	nfopr	salme
ydrjq	qarzu	bhfem	ooxzl
gredl	fijya	eivdg	nhyex
mjyra	qztls	siwfu	wfhel
narzq	eduwj	vsfab	skqud
ihxgf	ncjpa	fohwe	gaimf
ojrle	khhd		

6. While prefixing the message heading at the same time (see also II D above), the message is now ready for transmission and reads:

1755 - 129 wep hfi

ulzno	sgexu	nfopr	salme
ydrjq	qarzu	bhfem	ooxzl
gredl	fijya	eivdg	nhyex
mjyra	qztls	siwfu	wfhel
narzq	eduwj	vsfab	skqud
ihxgf	ncjpa	fohwe	gaimf
ojrle	khhd		

1755 = time group
129 = number of letters including the 5 letters of the identifier group
wep = normal position as selected by the encoder
hfi = encoded message key
ulzno = identifier group

7. To identify the cypher that is to be used for the encoding of the message, one of the four identifier groups (e.g., NUZ) is to be selected from the daily cypher (see VIII A above). This group is rearranged to read, for example, ZNU and, after prefixing two filler letters, such as UL, is entered as the first group.

sgexu nfopr . . . = encoded clear text

C. Decoding.
1. The message to be decoded is as in B6 above.

2. The first group of the encoded text is the identifier group. Having deleted the first two filler letters and arranged the remaining three letters in alphabetical order, the following identifier group letters result: NUZ. With these identifier group letters, the cypher that was used is identified and the coding machine is adjusted on the basis of the cypher applicable on that particular day.
3. The normal position to be used is taken from the message head (for example, WEP - 23 05 16) and set in the windows of the ENIGMA coding machine.
4. The three secret letters (HFI) of the message key that are located behind the three letters of the normal position (WEP) are keyed. The letters XFR that light up are the message cypher.
5. The encoder then arranges message cypher letters XFR (24 06 18) in the windows of the ENIGMA coding machine and keys the coded text. This procedure will produce letters as follows:

> gen kdo roem seqs angreift fuenften mai null drei vier fuenf uhr mit dritter und zehnter div feind bei maisach x gef stand milbertshofen nordausgang.

The final clear text reads as follows:

> *Gen. Kdo. VI angreift 5. Mai 0345 Uhr mit 3. und 10. Div Feind bei Maisach. Gef. Stand Milbertshofen Nordausgang.*

IX. GENERATION OF TRAINING KEYS

When generating training keys, the following will be observed:

A. Position of the cylinder must change daily. Cylinders I through V must be used.

B. To come up with the ring position, it is useful to cut out twenty-six pieces of cardboard (as in the Lotto game) and allocate them numbers 1 through 26. In this manner and as in the Lotto game, eight lines (e.g., eight days) may be identified in the *Ringstellung* column (two numbers are logically omitted each time). For example:

Day	**Position of Ring**	**Day**	**Position of Ring**
31st	24 14 08	27th	16 05 11
30th	17 01 13	26th	23 03 07
29th	25 15 19	25th	02 22 21
28th	26 12 10	24th	18 09 06

Thus, all numbers, with the exception of 04 and 20, have been used. In the same manner the ring position is established for the remaining days of the month.

C. To establish the ten plug-in connections, twenty-six little pieces of cardboard are cut out, of which twenty are randomly selected and placed together in pairs of two as plug-in connections. They are written down in a manner ensuring that within one letter pair, the letters ascend alphabetically (for example: KV IT BY FG CO EJ DP MR QS LX).

D. To designate the type of cypher to be used, four identifier groups of three letters each will be added to the daily cypher. While the identifier groups of the cyphers for the secret message traffic are determined by the supreme commanders of the individual armed forces services, the training cyphers may be selected simply by randomly establishing four-letter

combinations, each consisting of three letters, such as BLV, KUX, RTZ, SWY. The supreme commanders of the individual armed forces services are also free to issue identifier groups for training purposes or special cyphers.

CHAPTER 11

The M.w.E.c Receiver

I. DESCRIPTION

A. The *Mittelwellenempfanger* (middle-wave receiver model c), abbreviated M.w.E.c, is designed as a direction-finding intercept receiver. The M.w.E.c is used primarily with the 20-watt and 30-watt transmitters. The set is capable of receiving continuous wave (CW) and modulated signal (voice) over a frequency range of approximately 830 to 3000 kHz. The set is operated from a 12-volt storage battery in conjunction with the E.U.a dynamotor.

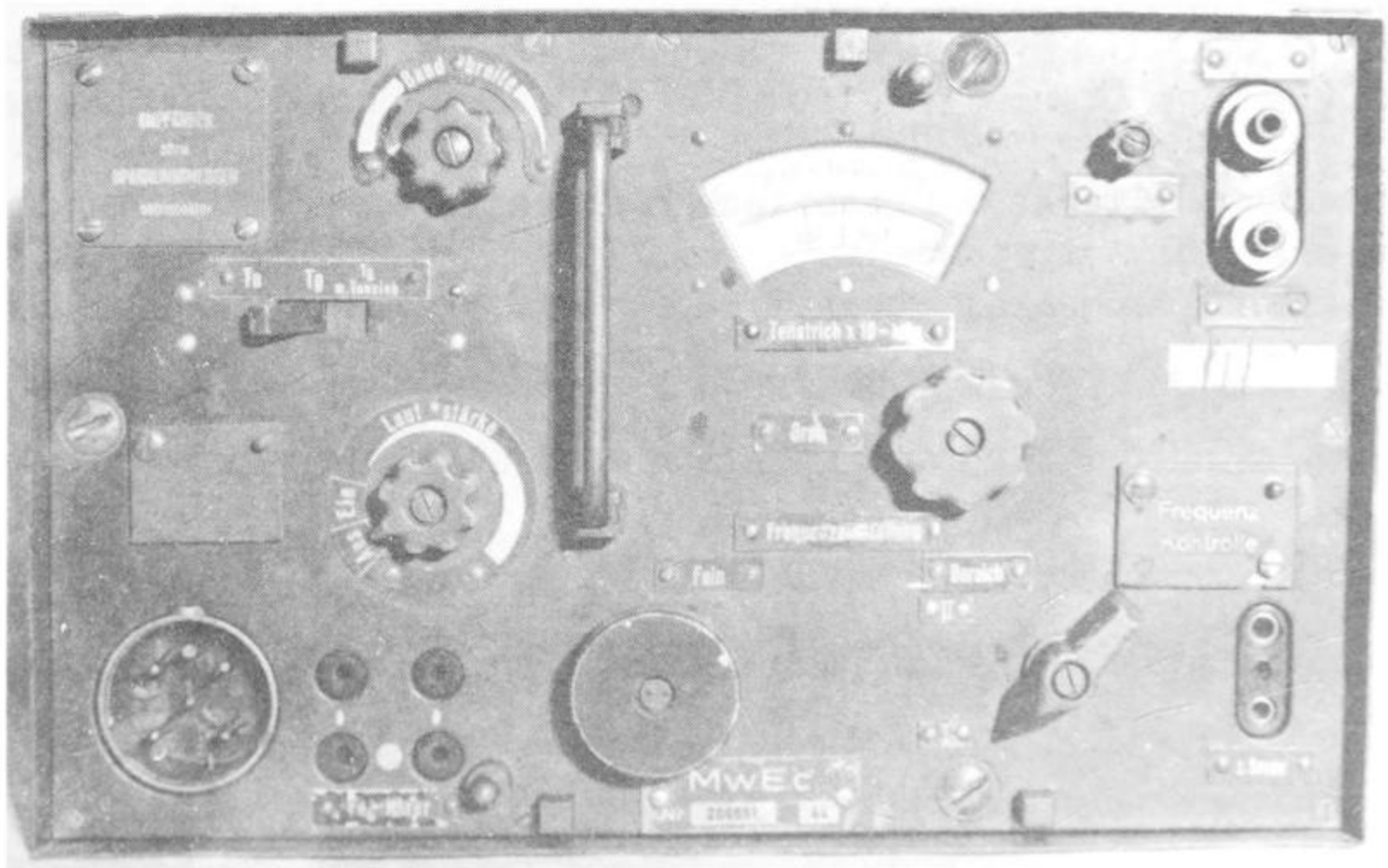


Figure 11.1 *Front view of the M.w.E.c with front cover removed.*

B. The following items are issued with the set:
1 set of headphones
1 antenna cable
1 E.U.a dynamotor and cable

II. PERFORMANCE DATA. The table below lists the performance and general characteristics of the M.w.E.c.

Frequency range
Band 1:830-1600 kHz
Band 2:1600-3000 kHz

Types of signal that may be received: CW, voice

Number of tubes: 9 RV12P2000

Power Supply: 12-volt vehicle storage battery through dynamotor E.U.a

Weight: 13 kilograms
Height: 20 centimeters
Length: 31.3 centimeters
Width: 18 centimeters

III. INSTALLATION

A. Location. When receiver and transmitter racks are provided in the vehicle, slide the receiver and dynamotor into the racks and press down the clamps on each side. If dynamotor racks are available, place the unit in the racks and tighten the wing nuts on the bolts that fit into the slotted lugs at the output end of the case.

CAUTION: Before making any connection, make sure that the control on the receiver marked *Aus Ein Lautstärke* is in the *Aus* position.

B. Cabling.
1. Connect the antenna lead to the binding post marked AI or AII.
2. Connect the sidetone cable from the jack marked *z. Sender* (to sender) on the receiver to the jack on the transmitter marked *z. Empf.* (to receiver).
3. Connect the receiver to the E.U.a dynamotor, first checking to see that the screws and pins are in the correct positions. Observe that the power cables are identical in construction.
4. When the E.U.a dynamotor is connected in its rack, connect the power cable from the 12-volt vehicle battery to the input receptacle.
5. Plug a headset into either of the jacks marked *Fernhorer* on the receiver. The set is now ready for operation.

IV. OPERATION: After the set is installed, it is put into operation as follows:

A. Turn the main switch on the transmitter to the *Empfang* position.

B. Turn the receiver main switch marked *Aus Ein Lautstärke* to *Ein*. Allow sixty seconds for the tubes to warm up.

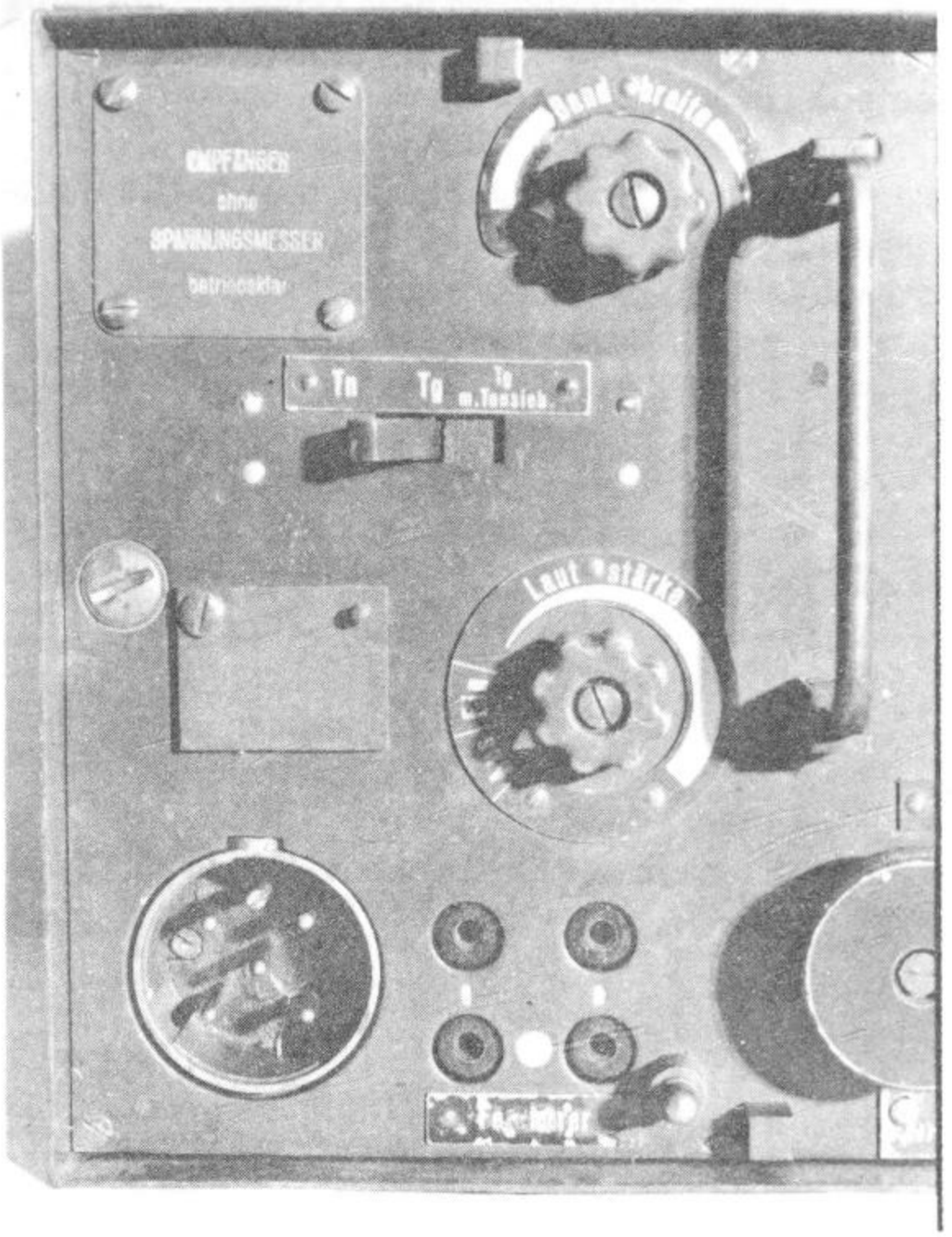


Figure 11.3 *Close-up view of the left side of the set. From top to bottom: cover plate for voltmeter installation, Bandbrite (selectivity dial), Tn Tg (voice/CW switch), Aus Ein (off/on), Laustärke (volume control switch), battery input receptacle, Fernhorer (headphone input jack).*

Figure 11.2 *Close-up view of the right side of the set. From top to bottom: frequency dial window, Anpass. (antenna matching unit binding post), Frequenzeinstellung Grob. (frequency dial large-scale setting), Frequenzeinstellung Fein (frequency dial fine-adjustment setting), Frequenzkontrolle (frequency control), position I and II, input jack for transmitter, nameplate.*

C. The pointer of the control marked *Frequenzeinstellung* should be tuned to the desired frequency.

D. Control the volume of the signal in the headset with the control marked *Aus Ein Lautstärke*.

E. To set the desired frequency, use either position switch I or II using the *Frequenzkontrolle*. Next, tune in the setting using control marked *Frequenzeinstellung* as described in C above.

V. CALIBRATION

A. Operator Procedures. If the receiver does not function perfectly, test the set as follows:

1. Insure all connections are properly made.
2. Test tuning.

a) Heaters below 10.8 volts: check heat connections to receiver transformers, accumulator, and fuses.

b) Anode tuning less than 116 volts: check transformer connections and transformer (bushing and starter relay).

3. All joining cables and plugs are to be tested for loose connections. Long-distance receiver and LDR cables are to be checked. Check antenna and multiple connection as follows.

Remove the receiver from its casing by loosening and removing the four red-edged holding screws.

4. Check tubes to ensure they are firmly seated.

NOTE: Do not change the oscillator tube; otherwise, the receiver will have to be reset to the built-in frequency.

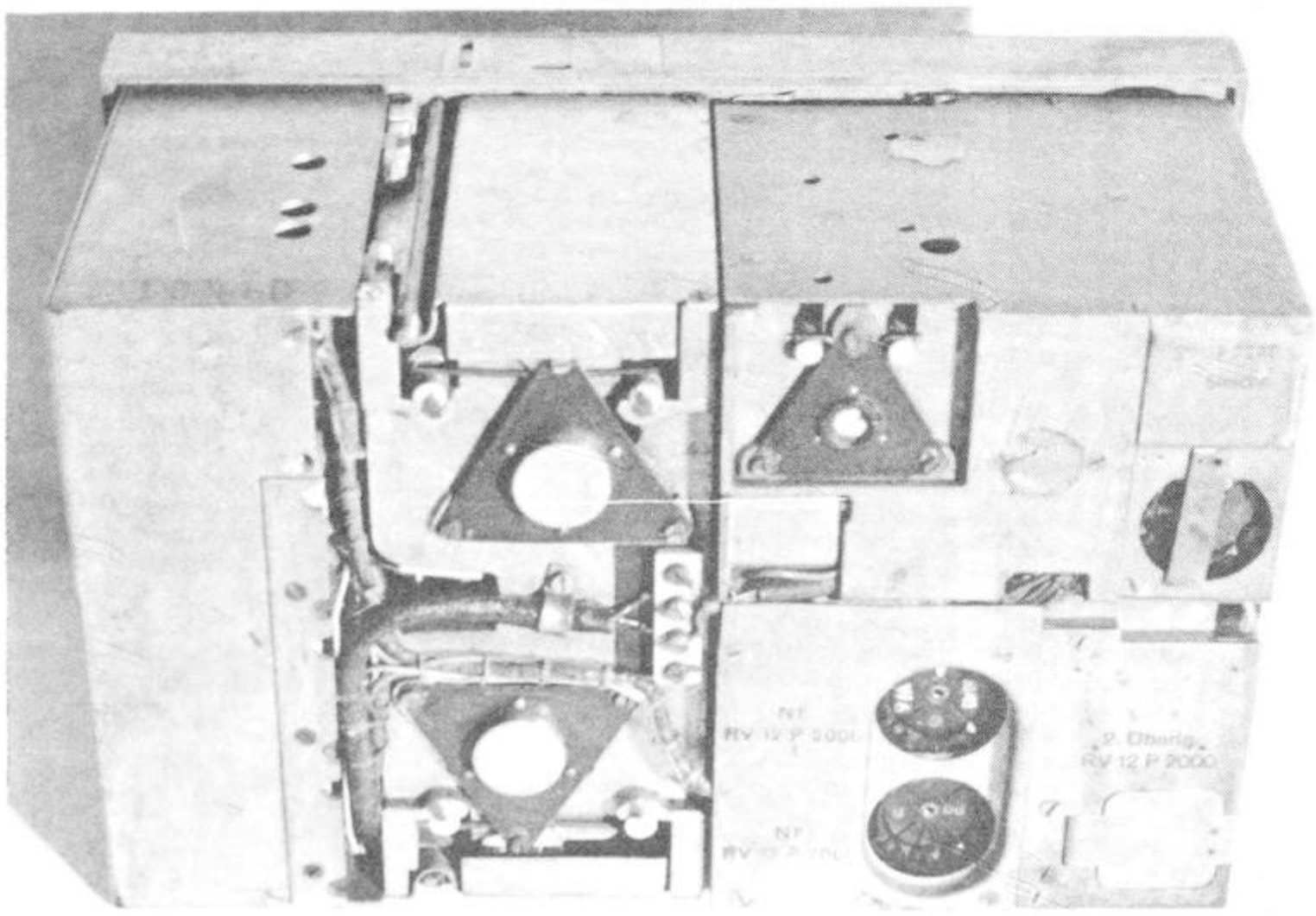


Figure 11.4 *Rear view of the M.w.E.c removed from its case.*

VI. MAINTENANCE

A. Changing tubes and frequency meter.

1. When frequency drift is noticed or suspected during operation, once a year, and before the beginning of a major training exercise, it is important to observe the frequency correctness of the receiver after every tube change in the oscillation step. Do so by plugging in the long-distance receiver and opening the cover plate to the frequency control after loosening the red-edged screws.

2. The following measurement points are given for each range:

a) Range 1

(1) Black sector: frequency 1069 kHz (283.3 meters)

(2) Black triangle: frequency 1412 kHz (212.5 meters)

b) Range 2

(1) Black sector: frequency 1765 kHz (170.0 meters)

(2) Black triangle: frequency 2824 kHz (106.2 meters)

3. Checking range 1.

a) Place the bottom point of the black triangle (*Bereich* switch) on frequency 1412 kHz on the frequency scale.

b) Turn the *Lautstärke* knob all the way to the right.

NOTE: Before commencing this frequency check, the receiver must have been switched on for a minimum of five minutes.

c) The following things can happen:

(1) You hear nothing from the receiver; you are in a dead zone. The receiver is functioning properly. Control this by using the frequency-calibration screw (setting the screw with occasional markings of the frequency range under the cover plate). By slowly twisting backward and forward to each side, a whistle tone becomes audible.

(2) You hear a whistling tone from the receiver; you are outside the dead zone. To this extent the receiver is functioning correctly. A little backward and forward rotation shows the direction in which the dead zone lies.

(3) You hear nothing from the receiver. Test as in VI A above. If during this test no sound is heard, it means the receiver is set to the point where the tone is outside hearing range. Now turn the connector settings farther until the whistle tone is reached, then set on the dead zone.

(4) In order to control the frequency test, set the black sector on frequency 1059 kHz. If the dead zone is inside the sector, then the receiver has retained its former precision frequency.

(5) If the dead zone is not within the sector, don't use the setting-connector screw anymore. Rather, send the set to the next higher level of maintenance along with your notes/remarks.

NOTE: The frequency tests for range 2 are similar to the steps followed for range 1.

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